PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

Vol. 45, No. 2, pp. 9–34, 12 figs. September 10, 1987

STUDIES IN THE INSECT ORDER EMBIIDINA: A REVISION OF THE FAMILY CLOTHODIDAE

By

Edward S. Ross

Department of Entomology, California Academy of Sciences, Golden Gate Park, San Francisco, California 94118

ABSTRACT: All thirteen species of Clothodidae are treated. The following taxa are new or recombined: *Clothoda longicauda* n. sp. (Peru); *Cryptoclothoda spinula* n. gen. and sp. (Brazil); *Antipaluria panamensis* n. sp. (Panama); *A. marginata* n. sp. (Colombia); *A. urichi* (Saussure), n. comb. (Trinidad); *A. intermedia* (Davis), n. comb. (Venezuela); *A. caribbeana* n. sp. (Venezuela); *A silvestris* n. sp. (Venezuela). *Chromatoclothoda* n. gen. (Amazon Basin); *C. elegantula* n. sp. (middle Amazon); *C. aurata* n. sp. (Peruvian montaña); *C. albicauda* n. sp. (Colombian montaña); *C. nigricauda* n. sp. (Peruvian montaña); *C. nana* n. sp. (Peruvian montaña).

Received June 23, 1986. Accepted September 19, 1986.

INTRODUCTION

In the South American family Clothodidae, especially in the genus *Clothoda,* the order's greatest concentration of plesiomorphic embiid features occurs, for example, almost perfect symmetry of male terminalia and the most complete, most uniformly cuticularized wing venation. If only the genus *Clothoda* were known, the family status would be unquestionable. However, I have recently discovered new species in the new genus *Chromatoclothoda*, and these species exhibit increasing specialization toward that of genera placed in other families.

Nevertheless, the family is retained as a natural group for genera in which males have symmetrical, unlobed cerci in combination with dentate mandibles, strongly cuticularized wing veins, anterior branch of media always forked, and little or no development of terminalia processes or lobes. Only in certain genera of the highly distinct Anisembiidae is there comparable symmetry of the cerci, but in these cases other portions of the terminalia are much more complex, wing venation is greatly reduced, and the mandibles lack multiple apical dentation.

Diversification of Clothodidae is of great evolutionary interest, for within the genus *Chromatoclothoda* are the beginnings of two major trends in terminalia structure and the associated copulatory mechanism; ultimately these structures are so advanced as to become subordinal characters.

MATERIALS AND METHODS

This revision is largely based on specimens I collected during several trips to South America and one to eastern Panama. Whenever possible, embiids encountered in the field were cultured as a means of securing ample series of adults for research and distribution to other museums.

As the first stage of a species description, I describe the holotype and then the characters of the allotype and other specimens before me. Only topotypic adults—usually from the holotype's culture—are designated as paratypes.

I drafted the illustrations from KOH-cleared

specimens mounted on microscope slides. Separate images in each plate are not always drawn to the same scale. Thickness of line and nonstippled shading reflect degrees of sclerotization. Membranous or fleshy areas are stippled. Only significant vestiture is indicated. Labrum is omitted in head figures.

Terminalia symbols are defined as follows: 9 = ninth abdominal tergum, 10 L and 10 R = hemitergites of tenth abdominal tergum, 10 LP and 10 RP = processes of these hemitergites, MS = medial sclerite of 10, MF = medial flap of 10, EP = epiproct (segment 11), ED = ejaculatory duct, H = hypandrium (sternum 9), HP = process of H, LPPT and RPPT = left and right paraprocts, LCB and RCB = left and right cercus-basipodites. Wing veins and sinuses are abbreviated as follows: C = costa, Sc = subcosta, ScBS = subcostal blood sinus, R = radius, RBS = radial blood sinus, Rs = radial sector, MA = anterior branch of media, MA1 and MA2 = branches of MA, MP = posterior branch of media, Cu = cubitus, CuA = anterior branch of cubitus, CuBS = cubital blood sinus, A = anal, ABS = anal blood sinus.

The following institutional abbreviations are used throughout the manuscript: AMNH = American Museum of Natural History, New York; BMNH = British Museum (Natural History), London; CAS = California Academy of Sciences, San Francisco (the author's collection); ICNB = Instituto de Ciencias Naturales, Bogotá, Colombia; IZAM = Instituto de Zoologia Agricola, Maracay, Venezuela; MIUP = Museo de Invertebrados, Universidad de Panamá, Panamá; MHNP = Museo de Historia Natural, Lima, Peru; MNR = Museu Nacional Rio de Janeiro, Brazil; MZSP = Museu do Zoologia, Universidade do São Paulo, Brazil; USNM = U.S. National Museum of Natural History, Washington, D.C.

Systematic Treatment

Family Clothodidae Enderlein

Clothodinae Enderlein, 1909:175 (subfam. of Embiidae); Enderlein 1912:21.

Clothodidae Tillyard, 1937:251.—Davis 1940*a*:536; 1940*b*:678; 1942:111.—Ross 1944:404.—Denis 1949:741.—Kaltenbach 1968:4.

Type genus.—*Clothoda* Enderlein, 1909, by original monotypy.

Distribution.—Amazon basin, northern South America, Trinidad, eastern Panama.

Diagnosis.—Males: Usually large but in a few species small. Coloration diverse. Wings always present; all veins well cuticularized, venation varying from most complete within order (MA always forked and CuA multibranched) to simple embioid type with CuA simple and few crossveins. Mandibles strongly apically dentate; submentum always sclerotic and inflexed on anterior and lateral margins. Hind basitarsi always with two ventral papillae. Abdominal terminalia highly symmetrical, varying from almost perfect symmetry in *Clothoda* to primitive asymmetry in other genera; tenth tergal processes undeveloped or, at best, short, simple lobes; paraprocts often equal, well sclerotized, but lacking processes or nodules; segments of left cercus identical to those of right cercus, never lobed or echinulate.

Females: Without unique family-level characteristics. Hind basitarsi always with two ventral papillae. Genitalia without pronounced lobes or sclerotizations.

Biology.—Species of this family occur in forests (or semicleared forest) of the Amazon, Orinoco, and Magdalena River basins, as well as in Trinidad and eastern Panama. Colonies usually are on tree bark (Fig. 1), rock ledges, and road banks. There is generic variation in appearance of the silk galleries. In *Clothoda* and *Antipaluria* they are fully exposed. In *Cryptoclothoda* and *Chromatoclothoda* they are covered with pulverized feces, debris, or micro-plant growth and thus are often difficult to find even when likely habitats are closely scrutinized.

Eggs are laid in single-layer clumps attached to a surface within the galleries. With her mandibles, the parent female deliberately places finely masticated material in and around the egg mass as it is laid. This protection, together with guarding by the parent, reduces oviposition by parasitic wasps. Nymphs develop in unison in a one-year cycle. They are highly tolerant of one another under crowded conditions within field and culture galleries.

Key to Genera of Clothodidae Males

1. Terminalia with paraproct sclerites (LPPT and RPPT) equal, or almost equal 2
— Left paraproct (LPPT) much larger than right (RPPT) 3
2. Terminalia with caudal apex of tenth tergum (MF) curled dorsad, tenth tergum (10) at best indistinctly cleft; epiproct (EP) small, inconspicuous. Head with gula bearing two

FIGURE 1. Colony of *Clothoda longicauda* Ross, new species, on trunk of rain forest tree near Tingo María, Peru. Apparently galleries of broods of two parent females have united. Occasionally, galleries of successive generations will completely envelope such trunks.

setal tufts anteriorly behind submental suture ..... *Clothoda*

— Apex of tenth tergum not curled dorsad; instead, it is broadly cleft forming two definite, similar, caudal lobes that are globose and coarsely setose dorsally; epiproct large, its sclerite conspicuous. Gula without setal tufts ..... *Cryptoclothoda*

3. Body sclerites uniformly dark (except in *caribbeana*); large, robust. Wing vein CuA at least two-branched (except in anomalous specimens); cross-veins numerous. Left

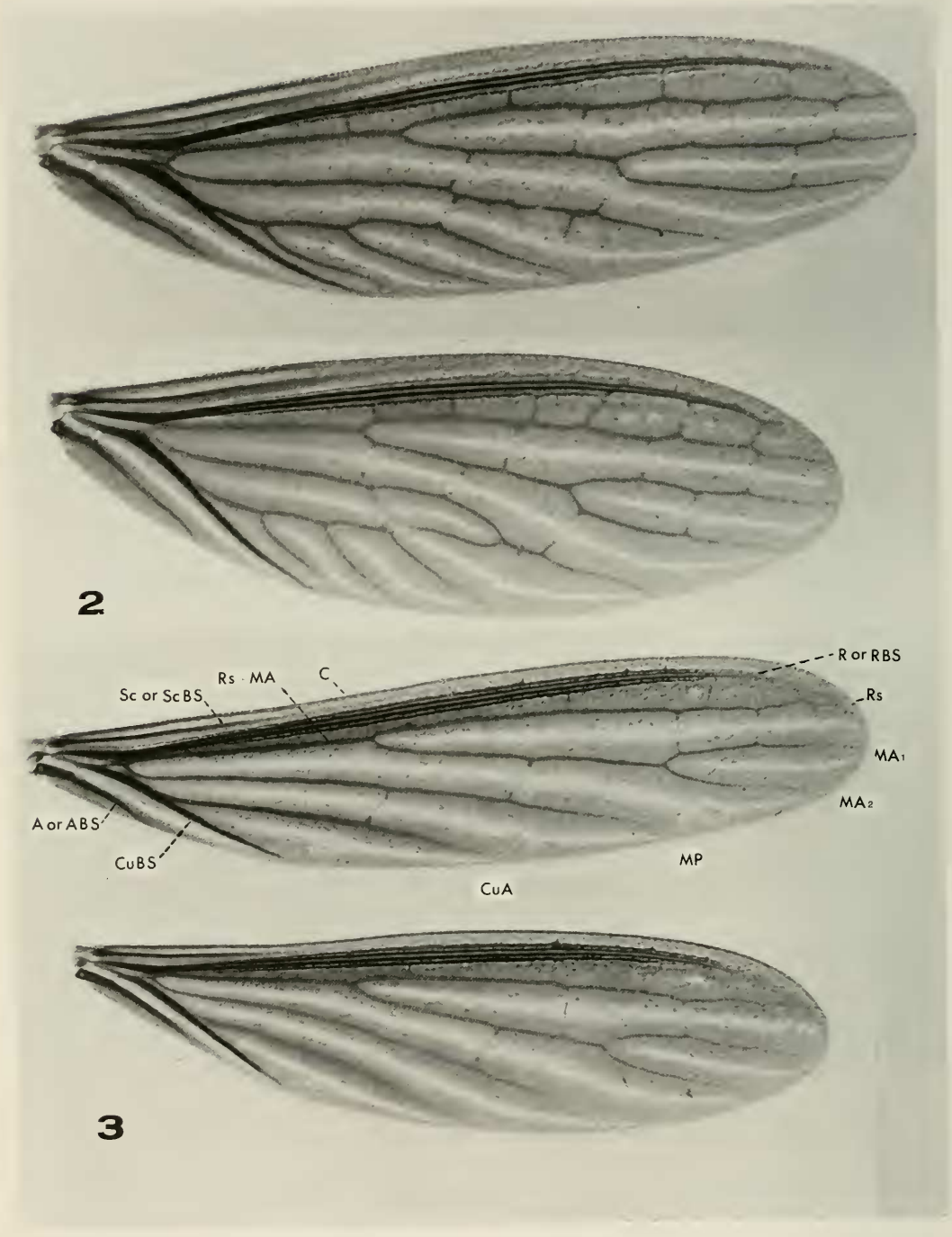

FIGURE 2. *Clothoda longicauda* Ross, new species, wings of paratype male. MP of hindwing is anomalous. Multibranched Cu is characteristic of *Clothoda*. FIGURE 3. *Chromatoclothoda albicauda* Ross, new species, wings of male from Mera region, Ecuador. A more distal forking of MA and the simple Cu characterize species of the genus *Chromatoclothoda*. For an explanation of symbols, see page 10.

hemitergite (10 L) with well-developed process (10 LP). Silk galleries conspicuous, not covered with pulverized material ..... *Antipaluria*

— Body sclerites multicolored (thorax entirely or partially golden); size medium to small, slender. Wing vein CuA always unbranched; few cross-veins (Fig. 3). Left hemitergite without a distinct, narrow process. Silk galleries inconspicuous, covered with pulverized material that at times supports microplant growth ..... *Chromatoclothoda*

Genus **Clothoda** Enderlein

Clothoda Enderlein, 1909:176; 1912:21.—Navás 1918:109 (tribe Clothodinos).—Tillyard 1937:250.—Davis 1939:373; 1942:111.—Ross 1944:404.

TYPE SPECIES.—*Embia nobilis* Gerstaecker, 1888, by original designation.

DISTRIBUTION.—South America: Amazon basin.

DIAGNOSIS.—Males: Very large, robust; alate; uniformly blackish brown. Cranium with mahogany, semitranslucent area between eyes, otherwise lacking pattern. Eyes small. Mandibles short, triangulate with coarse apical dentation; submentum sclerotic, sides inflexed and anteriorly convergent. Gular area with two tufts of setae immediately behind submentum. Prothorax robust, broader than head; concolorous with remainder of body. Wing veins strongly cuticularized to wing margin; CuA, and sometimes MP, branched at least once; cross-venation complex; costal margin white in type species. Hind basitarsi with two prominent, ventral papillae. Abdominal terminalia very symmetrical; tenth tergum uncleft, or only partially cleft; medial sclerite (MS) large and basally projected beneath ninth tergum (9); tergal apex (MF) elevated and curled basad; tergal processes either undeveloped, or at best, budlike; epiproct (EP) merely a fleshy, unsclerotized lobe beneath MF; ninth sternum (H) evenly but weakly sclerotized throughout, abruptly projected caudad as a symmetrical, medial process (HP) which is slightly cleft and microsetose at apex (ED); left and right paraproct sclerites (LPPT and RPPT) elongate, equal in size, convergent along sides of HP; left and right cercus-basipodites (LCB and RCB) similar, sclerotized dorsally only; left and right cerci equal, segments very elongate, evenly sclerotized, distal segment never pale.

Females: With coloration paralleling that of males but with distal antennal segments abruptly white. Body somewhat flattened, prothorax exceptionally broad, but otherwise without important generic anatomical characters.

COMPONENT SPECIES.—*Clothoda* is here restricted to its type species, *C. nobilis* (Gerstaecker 1888), which appears to be widespread in the mid and lower Amazon basin, and also a very distinct new species occurring in the Peruvian tributary region of the Amazon. Other species previously assigned to the genus are here placed in the genus *Antipaluria* Enderlein. The Tertiary fossil *Embia florissantensis* Cockerell (1908), placed in *Clothoda* by Davis (1939), has been assigned to the new genus *Lithembia* Ross (1984) because its wing venation is not of the *Clothoda* type and there is no evidence for placement in a Recent genus.

Key to Species of *Clothoda* Adult Males

1. Costal margin of wings cream-white; tenth abdominal tergum completely sclerotized except for small membranous area anterior to its upturned apex (MF). Antennal segments VIII–XVI ventrally bearing dense clumps of short, truncate setae. Lower and middle Amazon region of Brazil..... *nobilis*

— Costal margin of wings blackish-brown; tenth abdominal tergum weakly cleft, membranous on left side of upturned apex (MF). Ventral setae of antennal segments VIII–XVI normal, not short and peglike. Montaña region of Peru..... *longicauda*

Clothoda nobilis (Gerstaecker)

(Figure 4)

Embia nobilis Gerstaecker, 1888:1.

Embia (Olyntha) nobilis Krauss, 1899:148.

Olyntha nobilis (Gerstaecker) Krauss, 1911:31.

Clothoda nobilis (Gerstaecker) Enderlein, 1909:176; 1912:22, fig. 4–6, pl. 1, A–B.—Navás 1918:109, fig. 6.—Davis 1939:373, fig. 1–7.—Ross 1944:406.

NEOTYPE (BY PRESENT DESIGNATION).—Male, McLachlan Collection, BMNH. Data: "Itaituba (Amazonas)," Brazil.

Gerstaeker's type specimen is apparently lost. It is not in the Zoologisches Museum, Humboldt-Universität zu Berlin where Gerstaeker's collections presumably were deposited. I found no trace of it in any other museum.

His type specimen was from Itaituba, and it is likely that it and the neotype, as well as a male (labelled *Olyntha brasiliensis* Gray, possibly by

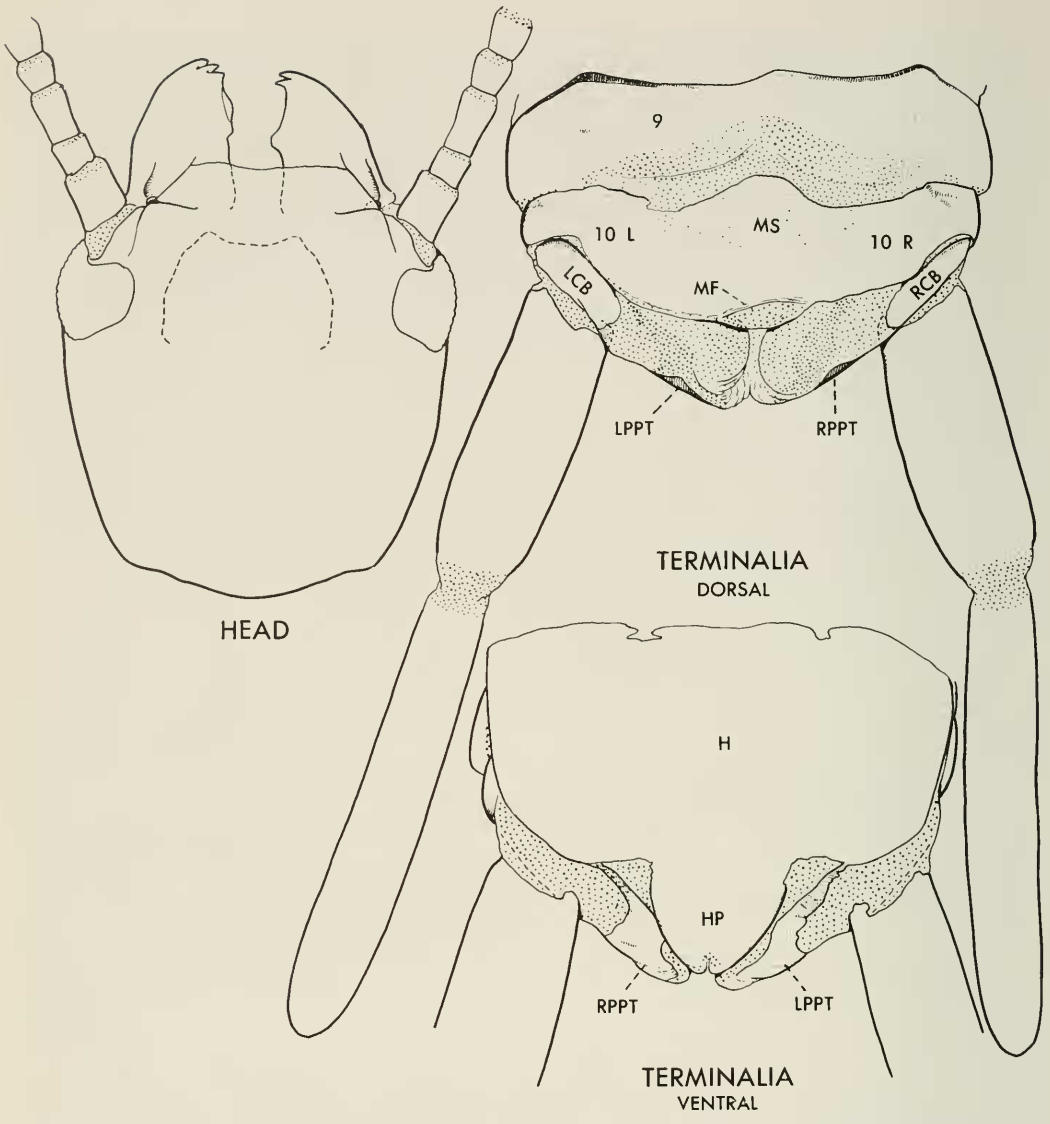

FIGURE 4. *Clothoda nobilis* (Gerstaecker). Head and terminalia of a male from Manaus region, Brazil. For an explanation of symbols see page 10.

Krauss) in the Naturhistorisches Museum, Vienna, were collected by H. W. Bates and divided among his clients.

McLachlan's specimen was described by Davis (1939) and I tentatively designated it lectotype (1944). However, because it was not studied by Gerstaeker, it cannot be considered a lectotype.

I have collected and reared extensive series of this remarkable species from the Manaus region, as well as Serra do Navio, Amapá, northeastern Brazil. The biology of *C. nobilis* is similar to that described for *C. longicauda* new species of the upper Amazon.

Adult males are easily distinguished by globose antennal segments that are largest in the medial portion of the antennae. Eight of these submedial segments (VIII–XVI) bear dense, ventral clumps of peculiar, short, truncate setae. The costal and

anal wing margins are whitish, and the terminalia are unique in that they lack medial cleavage of the tenth abdominal tergum. The apex of the tergum, however, is curled dorsad, and this apex probably is homologous to the medial flap which, in more apomorphic genera, becomes diagonal, or longitudinal, in position and attaches to the inner margin of the right hemitergite. Tergal surfaces on either side of the flap eventually evolve into left and right hemitergal processes in other species of the order.

Additional Old Record.—Brazil: Fonte Boa (Amazonas), two adult males and one adult female, Enderlein Collection, Instytut Zoologiczny, Warsaw.

New Records.—All Amazon basin, Brazil: Reserva Ducke, 25 km N Manaus; large colony on trunk of remnant tree in semi-cleared virgin forest, males matured 14-X through 31-XII-64 (Ross). Twenty km N Manaus, colonies common on tree trunks in yard of farmhouse, males matured 18-VIII through 5-X-65 (Ross). Serro do Navio, Amapá; colony on tree trunk in virgin forest, males matured during every month of 1964 but mostly during January, 1965 (Ross). Porto Platon 21-II-64; 1 female on bark (Lacombe). Casa do Sette, Amapari R.; one adult female, underside of house 19-II-65 (Lacombe). Ponte da Bolivia, Amazonas, 20-X-60; one adult male, three nymphs (Evangelista). All in CAS collection.

Clothoda longicauda Ross, new species
(Figures 1, 2, 5)

Holotype.—Male, on slide, CAS. Data.—Peru: 3 miles (5 km) W Tingo María, Huánuco, X-54 (Ross).

Description.—Appearance: very large, uniformly dark brown, including wing margins, but with whitish-tan antennal apices. Color details (in alcohol): cranium dark chocolate-brown; darkest in clypeal region, becoming lighter brown caudally and ventrally; vertex between eyes with large, golden, transverse spot. Eyes dark lavender-brown. Basal antennal segment blackish, other segments dark brown with white joint-membranes; two distal segments tan apically, white basally; antepenultimate segment medium brown apically, tan basally (complete antenna 20-segmented). Clypeolabral membranes pale lavender; labrum dark brown; mandibles dark mahogany; other mouthparts various shades of dark-to-medium brown. All body sclerites and legs essentially dark brown with golden-brown areas, especially ventrally; all body membranes dark lavender. Wings appearing dark brown with strong violaceous luster; hyaline intervals very narrow; costal and radius borders dark; crossveins numerous, white when crossing hyaline intervals. Abdominal terminalia dark brown basally, caudal extremities tan to whitish (in membranes); cerci uniformly light brown. Dimensions (on slide): Body length 18.0 mm; fore wing length 11.2 mm, breadth 3.0 mm.

Important anatomical characters: Cranium short, broad; surface slightly depressed behind pale central spot; two shallow, sublateral carinas extend from inner curve of eyes and parallel lateral margins of cranium; medial stem of ecdysial suture finely carinate; cranial surface minutely reticulate but coarsely rugulose caudally in symmetrical pattern; gula, just behind tentorial pits, bearing two prominent clumps of dense, dark setae. Medial antennal segments without ventral, peglike setae. Abdominal terminalia relatively small, narrow; cerci exceptionally long, basal segment as long as apical; medial area of tenth tergum extensively membranous, almost completely cleft to apex; tergal processes not actually developed but precursors are evident; epiproct, as in *C. nobilis*, a small membranous lobe without a sclerite; paraprocts almost equal, the left slightly broader than the right.

Allotype.—Female (in alcohol) with holotype data and disposition.

Description.—Appearance: Large, robust, uniformly blackish-brown with dark membranes except for pale cranial spot and white apical segments of antennae. Color details: dull black except for transverse, rectangulate, golden area between eyes; antennal segments I–XVIII dark brown, remainder cream-white except for tan tip of segment XXIII (apical). All dorsal body sclerites blackish-brown with a faint green to purplish luster; ventral sclerites mostly mahogany-brown; all body membranes dark lavender. Legs essentially concolorous with body except for chestnut-brown femur-tibial joints and much of basitarsi of fore and mid legs. Apical segment of cerci medium brown blending to tan at apex. Prothorax exceptionally broad, as wide as cranium. Abdominal apex narrow and small; genital sternites and valvifers without notable features. Body length: 20.0 mm.

Paratypes.—Hundreds of reared adults from cultures collected in the immediate vicinity of Tingo María; in AMNH, BMNH, CAS, MHNP, and USNM.

Discussion.—Males of *Clothoda longicauda* are readily distinguished from those of *C. nobilis* by their more slender form, pale cranial spot, absence of peglike setae ventrally on medial antennal segments, entirely dark wing margins, more extensively cleft tenth abdominal tergite, and longer segments of cerci.

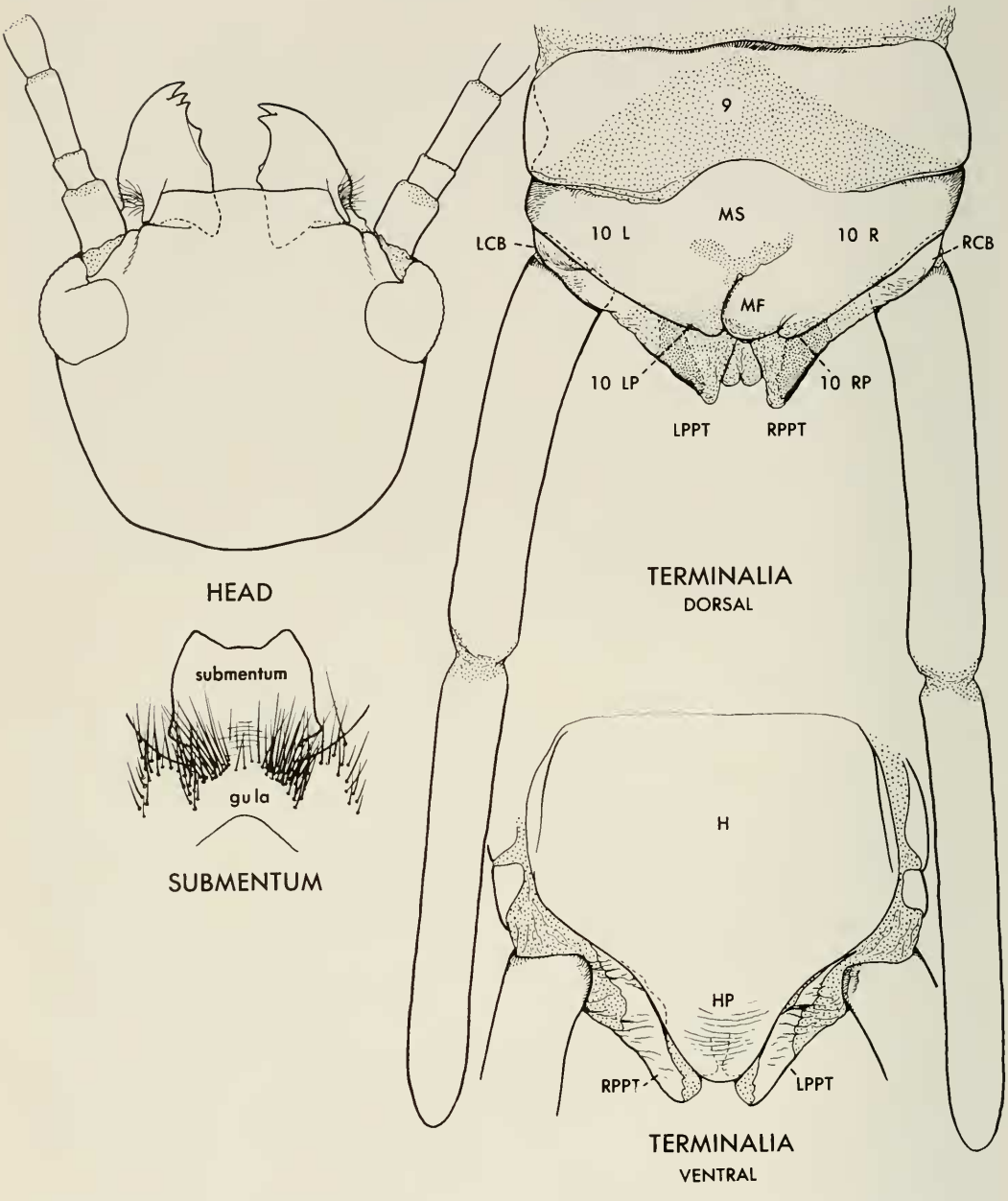

FIGURE 5. *Clothoda longicauda* Ross, new species. Head and terminalia of holotype. For an explanation of symbols see page 10.

Slight differences from locality to locality suggest that races may have differentiated.

BIOLOGY.—As in *Clothoda nobilis,* colonies of *C. longicauda* are rare and widely dispersed in virgin forest. Occasionally, however, a particular tree—usually a standing dead tree with rough bark—is almost completely enveloped by exposed, interconnected, white, silk galleries. Trees adjacent to such a concentration tend more frequently to have at least one small, pioneer colony.

The largest concentrations of *C. longicauda* (in fact, of all embiids) are found in partially culti-

vated areas adjacent to natural forest. Especially rich are new coffee plantations where some of the original forest trees remain standing to provide shade. Here, stumps, fence posts with bark still attached, as well as living trees, are common habitats. Occasionally, *C. longicauda* also occurs on surfaces of mossy rocks and old road or trail banks.

The gallery silk is fully exposed, white, and without a powdery cover of masticated material. Some galleries lead into protective crevices, but most colonies are entirely superficial, the layers of silk affording the same protection to galleries beneath as a layer of bark. The eggs are laid in a single-layer patch in a matrix of masticated material. Early-stage nymphs produce their own gallery systems beneath the cover of older galleries. Nymphs of both sexes are reddish-brown with white-tipped antennae. Adult males and females matured in greatest abundance in cultures during October and November, but it is possible that generations overlap and that adults may be encountered in the field at any time of the year.

The species is parasitized by a large, undescribed species of Sclerogibbidae, as well as by the tachinid fly *Perumyia embiaphaga* Arnaud, 1963.

Locality Records (all eastern Peru).—Boquerón de Padre Abad, Huánuco; colony on rocky ledge, males matured during XI-54. Yurac Plantation, Loreto (67 mi [108 km] NE Tingo María); colonies on tree trunks, males matured mostly during X-54. Yarina Cocha, Pucallpa, Loreto; colonies on tree trunks, males matured X-54. Two mi (3 km) W San Ramon, Junín; colonies on stumps in coffee plantation, males matured VII-55 through X-55. Collected by me and deposited in CAS.

This, or related species of *Clothoda,* were unsuccessfully sought (in habitats similar to that of the type series) in the Madre de Dios region of Peru, the Napo-Pastaza region of Ecuador, and the upper Putumayo region of Colombia.

Cryptoclothoda Ross, new genus

Type Species.—*Cryptoclothoda spinula* Ross, new species.

Distribution.—Brazil: Lower Amazon (one record).

Diagnosis.—Males: as large as, or larger than, those of *Clothoda,* alate, uniformly blackish-brown except for contrasting golden prothorax. Cranium without translucent, paler area between eyes; sides straighter and more caudally convergent than in *Clothoda*; gula without two anterior setal tufts. Eyes large, inflated; length almost equal to that of sides of head behind eyes. Antennae with segments of distal half very elongate; all segments bearing long, wavy setae; without ventral peg-setae. Mouthparts as in *Clothoda.* Prothorax narrower than head, golden-yellow; thorax and legs narrower than in *Clothoda.* Wings with vannal area narrowly tapered, caudal margin straight (curved in *Clothoda*); all veins strongly marked, broader than in *Clothoda* and most other embiids; CuA unforked. Hind basitarsi as in *Clothoda.* Abdominal terminalia with tenth tergum broadly cleft medially (almost to base of tergum), forming almost equal hemitergites that are depressed and almost devoid of setae just before production of caudal processes; left process (10 LP) smaller than right, short, thumblike, well sclerotized, upper surface bristling with numerous short setae; right process (10 RP or MF) equal in length to 10 LP but broader and submembranous on inner-apical side, dorsal surface densely setose, setae short and directed laterad and caudad; epiproct (EP) large with dark, sclerotic, rodlike sclerite. Ninth sternum (H) symmetrical, evenly sclerotized; its process (HP) centered, symmetrical, short, apex rounded, membranous except for a narrow sclerotized medial area. Paraprocts (LPPT and RPPT) very similar, left only slightly broader, each narrowly attached to sides of H. Cercus-basipodites (LCB and RCB) obsolete. Cerci perfectly symmetrical.

Females: Without important generic characters.

Component Species.—Only the type species is known, but others may be expected in the vast Amazon basin.

Discussion.—*Cryptoclothoda* is somewhat intermediate between *Clothoda* and *Chromatoclothoda.* It is more *Clothoda*-like in the great symmetry of its abdominal terminalia, especially that of its processes, hypandrium, and paraprocts. However, *Cryptoclothoda*'s galleries, like those of *Chromatoclothoda,* are very cryptic, being not fully exposed and detritus-free, as are those of *Clothoda* and *Antipaluria.* It differs from *Chromatoclothoda* in being much larger, more robust, and in having a more distinctly developed left tergal process and a less-developed left paraproct.

It is probable that both tergal processes are actually homologs of the medial flap. If so, in this genus the flap is cleft into two almost identical "processes." The left becomes the diverse left tergal process characteristic of almost all embiids, while the right is homologous to the medial flap of most embiids. The right tergal process of such embiids appears to derive from the caudal angle of the right hemitergite.

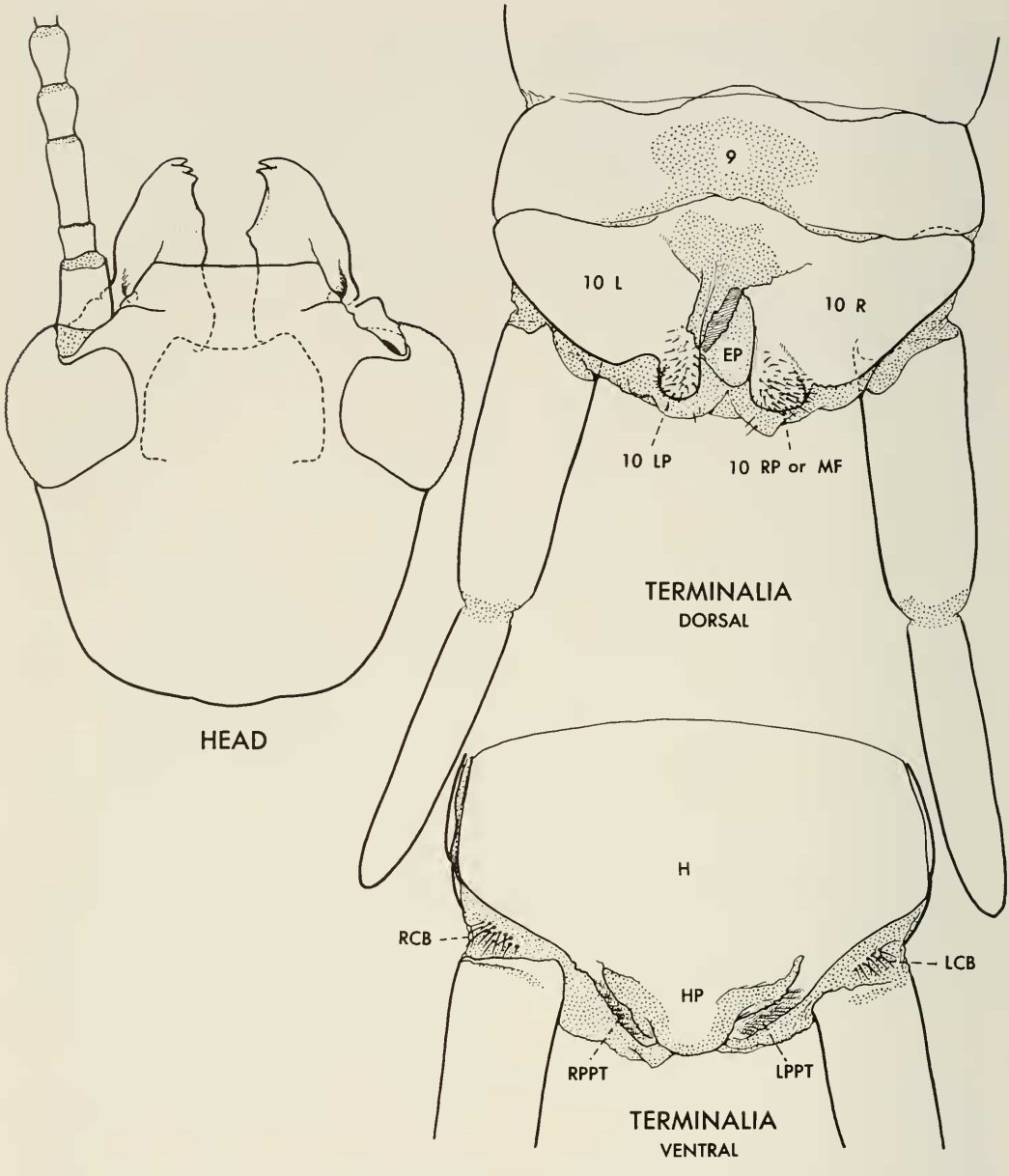

FIGURE 6. *Cryptoclothoda spinula* Ross, new genus and species. Head and terminalia of holotype. For an explanation of symbols see page 10.

Cryptoclothoda spinula Ross, new species
(Figure 6)

HOLOTYPE.—Male, on slide, CAS. Data.—Brazil: 50 km N Paragominas, Pará; silk gallery in bark crevices of recently felled tree in virgin forest. Matured in culture 28-V-75 (Ross).

DESCRIPTION.—Appearance: Very large, as large as *Clothoda nobilis*, alate; generally blackish except for contrasting golden prothorax; antennae and cerci entirely blackish, legs entirely blackish except for tan on sides of hind femora. Color details (in alcohol, freshly killed): Cranium dark chocolate-brown with matte luster; raised, shiny, transverse, medial, dark amber area between eyes; tentorial pit areas yellow-amber; gu-

lar bridge and margins of foramen magnum amber. Eyes pale purple with narrow, whitish outline. All antennal segments shiny black with pink membranes; 21 segments present, terminals broken off during capture, but these were also black. Preclypeal and labral membranes pink; labrum blackish. Mandibles dark amber with piceous dentation. Maxillae pale amber except for blackish palpi. Labium blackish except for amber mentum and piceous anterior margins of submentum. Cervical and prothoracic sclerites translucent yellow (except caudal angles of pronotum); all associated membranes almost concolorous, except for rust-yellow subdermal tinge. Pterothorax largely pale straw-yellow dorsally with symmetrical light brown clouding; sternites various shades of brown, adjacent membranes tinged rust-red. Legs various shades of brown except for tan areas on hind femora; mid and hind coxae dark gray-tan. Wings generally dark with narrow hyaline intervals; in sidelight the pigment bands appear brilliant metallic purple and the veins metallic cobalt-blue; granular borders of RBS very pale pink. Abdomen with basal terga light brown, terga IX and X blackish-brown; all dorsal membranous areas salmon-pink except for cream pleural fold of segments I–VI; ventral sclerites tan except for mahogany-brown sides, terminal segments becoming darker, hypandrium and paraprocts blackish-brown with associated membranes reddish. Cerci very dark brown with joint membrane reddish. Dimensions (on slide): body length 17.0 mm; fore wing length 12.0 mm, breadth 3.0 mm.

Important anatomical characters (Fig. 6): Head with distinctively large eyes. Terminalia highly symmetrical with unusual tenth tergal processes. These are short, rounded, globose with numerous, stiff, short setae; right process (10 RP or MF) almost twice as broad as left (10 LP).

Allotype.—Female, in alcohol, with same data and disposition as holotype (from same field colony), killed 31-X-75, failed to mate with holotype and thus unable to lay fertilized eggs.

Description.—Appearance: Large, robust; various shades of dull, mahogany brown with white antennal apices and cream-white dorsopleural abdominal membranes. Color details: Cranium dark chestnut-brown except for frons and medial area of clypeus which are dark mahogany-brown; lateral areas of clypeus golden-brown. Eyes lavender-black. Antennal segments I–XXIII shiny-black, segments XXIV–XXVI (the apical) white with purple joints. Anteclypeal and labral membranes white, tinged with purple. Submentum, mentum, palpi, labrum, and mandibles dark mahogany-brown. All other sclerites golden-brown. Cervical area pale purple. Pronotum mottled mahogany-brown; clouded with yellow-tan medially, forming indefinite, pale, longitudinal stripe. Meso- and metathorax mottled, dull mahogany-brown; with subcutaneous, pale clouding on promontories of meso- and metascuta, metascutum darker than mesoscutum and with purplish luster. All thoracic membranes lavender. Legs various shades of chestnut- and mahogany-brown dorsally; ventral surfaces of coxae, trochanters, and femora of mid and hind legs shades of pale yellow; distal tarsal segments pale. Abdomen concolorous with thorax but less dull in luster; segments I–VII with distinct, subcutaneous, cream, dorsopleural membranes forming pale, longitudinal, bordering lines; distal segments darker brown, especially laterally on paragenital sternites; all ventropleural and paragenital membranes purple. Cerci uniformly dark mahogany. Body length (in alcohol): 19.0 mm.

Biology.—Nymphs of the type pair were collected in virgin rain forest on 27-II-75. Their silk galleries were difficult to detect, being partially covered by vines growing up the trunk of a large forest tree that had been recently pushed over to make an access road for timber removal. When the tree was standing, the galleries would have been at least 50 feet (15 m) above ground level but it is doubtful that the species is confined to upper trunk levels. Probably many nymphs were present on the tree but their galleries were almost impossible to find because of dense epiphytes. I spent several days fruitlessly searching for additional colonies but found none, nor did I find the usually conspicuous galleries of *Clothoda*.

Late in May, 1975, the two nymphs matured in culture as a male and a female. They were kept alive together for a period that seemed sufficient to insure mating. However, after five months, when the female had failed to lay eggs, she was killed and preserved. It is assumed that she had failed to mate. In spite of this, the two individuals are unquestionably conspecific, probably siblings.

Antipaluria Enderlein

Antipaluria Enderlein, 1912:63.—Navás 1918:106.—Davis 1939:373 (as syn. of *Clothoda* Endl.).—Ross 1944:411 (as syn. of *Clothoda* Endl.).

Type Species.—*Antipaluria aequicercata* Enderlein, 1912, by original designation.

Distribution.—Northern South America, Trinidad and eastern Panama.

Diagnosis.—Males: Similar to those of *Clothoda* except as follows. Gula with setae uniformly distributed, without two anterior clumps. Antennae without ventral peg-setae. Abdominal terminalia completely cleft to base; medial sclerite (MS) obsolete, its area entirely membranous; left hemitergite with distinct but small caudal process (10 LP) projected from inner margin is often membranous on inner side; and up-turned right process (10 RP or MF) short, triangulate, somewhat fleshy (this process may be derived from medial flap (MF) which is otherwise absent); epiproct (EP) developed as short flap between hemitergites, its sclerite well sclerotized but narrow; ninth sternum (H) broader than long, caudal angles gradually converge to form broad-based, short, medial process (HP), which is asymmetrically membranous on caudal margin and not terminally cleft as in *Clothoda;* left paraproct (LPPT) as in *Clothoda,* but shorter and broader at apex; right paraproct (RPPT) reduced to a narrow sclerotic fragment fused to basal margin of HP; left and right cercus-basipodites (LCB and RCB) dorsally obsolete; each represented lateroventrally by sclerotic fragment, or setose membranous area; left and right cerci perfectly symmetrical, segments shorter than in *Clothoda,* apical segments usually concolorous with basals but at times paler.

Females: Without significant generic characters. Unlike those of *Clothoda,* membranous areas often pale, forming distinctive pattern, especially pale lines along the upper pleurae of the abdomen.

Discussion.—Because of the great superficial resemblance to *Clothoda,* and the conformity of many characters, *Antipaluria* was not recognized by Davis (1939) or myself (1944). Now that I have studied both genera in the field and laboratory and have discovered several new species, I am convinced that *Antipaluria* is distinct in many ways, such as the absence of two setal tufts anteriorly on the gula, the well-developed tenth tergal cleft and processes, the well-developed epiproct and its sclerite (rudimentary in *Clothoda*), and the asymmetrical paraprocts.

The seven species in my collection (CAS) may be assigned to three groups, as follows: (1) the Aequicercata Group, males of which have a narrow, evenly sclerotized left tergal process; (2) the Urichi Group with the left tergal process sclerotized only on its left side and the antennal apices white; (3) the Marginata Group with left tergal process as in the Urichi Group but with antennae uniformly dark and the wings white-margined. When northern South America is thoroughly surveyed for embiids, many additional species should be discovered. In combination with geographic occurrence, adult males of the known species may be distinguished as follows.

Key to Species of *Antipaluria* Males

1. Costal margins of wings whitish. Apical antennal segments dark. Colombia, east of Andes (Marginata Group) ..... *.marginata*
— Costal margins of wings dark. Apical antennal segments whitish 2
2. Epiproct sclerite (EP) curved, rather broad, its base not contacting inner side of right hemitergite (10 R) (Aequicercata Group). 3
— Epiproct sclerite straight, very slender, its base contacting inner side of right hemitergite (Urichi Group) 4
3. Left mandible broadly arcuate between apical dentation and molar cusp. Left tergal process (10 LP) very narrow, sides sclerotized except at extreme apex. Colombia W of Andes ..... *.aequicercata*
— Left mandible with a large, acute flange in above-mentioned position. Left tergal process broad basally, gradually tapered; sides and apex desclerotized. Panama E of Canal ..... *.panamensis*
4. Clypeus flat, anterior margin straight. Trinidad ..... *.urichi*
— Clypeus vaulted medially, anterior margin emarginate on either side of this promontory. Venezuela 5
5. Thorax unicolorous brown. Caracas region ..... *.intermedia*
— Prothorax entirely or partially golden or amber-yellow 6
6. Cervical sclerites dark. Pronotum dark except for golden to amber-yellow caudal third. Tropical mountain forest, Rancho Grande .. .. *.silvestris*
— Cervical sclerites and prothorax entirely golden-yellow. Lowland, coastal forest .... *.caribbeana*

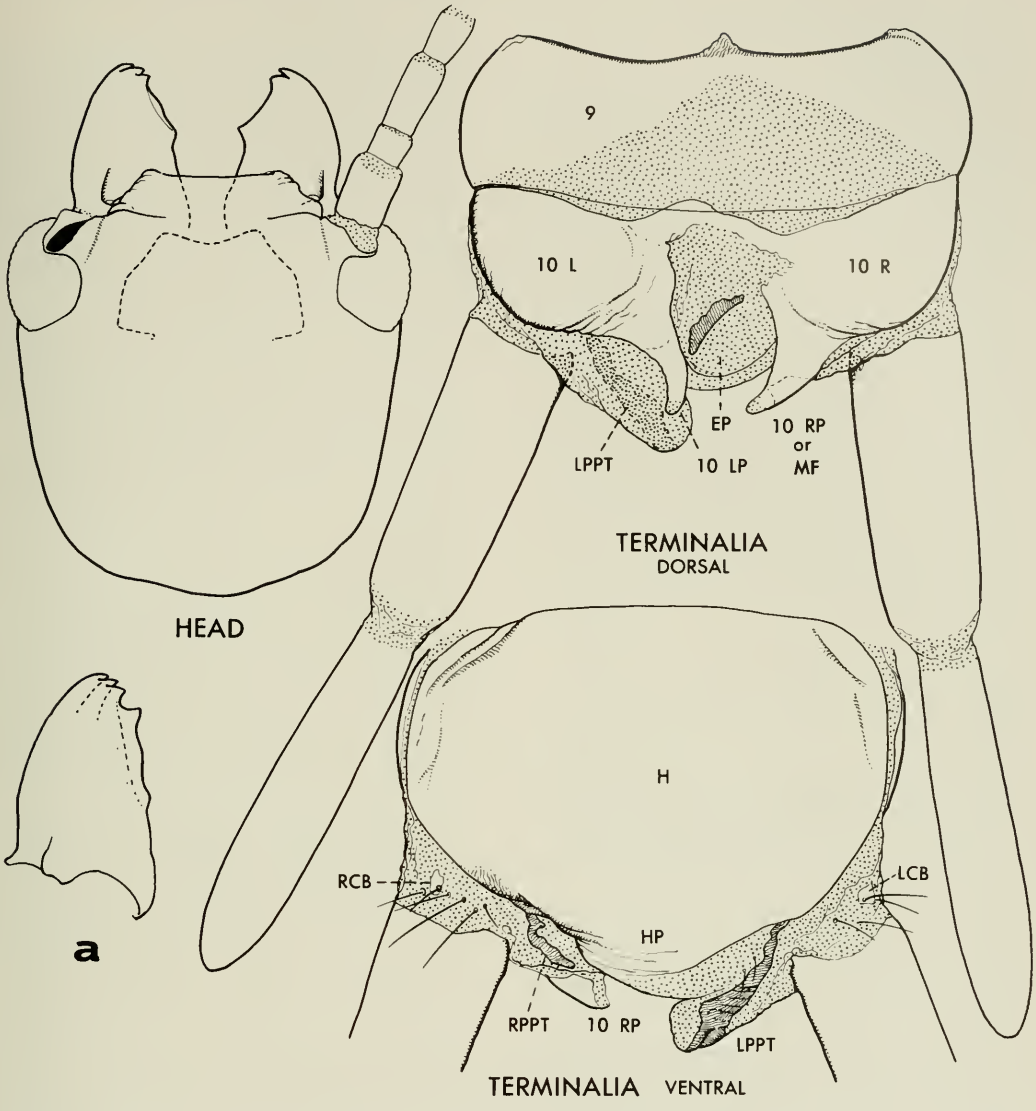

FIGURE 7. *Antipaluria aequicercata* Enderlein. Head and terminalia of neotype. For an explanation of symbols see page 10. Figure 7a. *Antipaluria panamensis* Ross, new species. Left mandible of holotype.

The Aequicercata Group

Antipaluria aequicercata Enderlein
(Figure 7)

Antipaluria aequicercata Enderlein, 1912:63.—Navás 1918:107.—Matsuda 1960:718, pl. I, fig. 5, 6 (anatomy of thorax).

Clothoda aequicercata (Enderlein) Davis, 1939:379.—Ross 1944:410, fig. 10–13.

NEOTYPE (BY PRESENT DESIGNATION).—Male, on slide, CAS. Data.—Colombia: 3 mi (5 km) E Guadas, Cundinamarca, 1240 m, 3-III-55 (Ross). From colony on shaded, mossy road bank.

Enderlein's unique type, an adult male with damaged terminalia collected by Moritz, was labeled "Columbien." It was deposited in the "Berliner Zoologischen Museum (Kat. Nr. 2734)." According to Dr. St. von Kéler, who loaned me types of other Enderlein species in this museum (now Zoologisches Museum, Humboldt-Universität zu Berlin), the type specimen of *A. aequicercata* is lost; also because this species is the type of a genus, and had no specific type locality

within Colombia, the present designation of a neotype is justified.

DESCRIPTION (OF NEOTYPE).—Appearance: Large (body length 18 mm); blackish-brown throughout except for white antennal apices and dark, metallic-blue wing luster. Cranium relatively small, greatest width behind eyes equal to broadest portion of prothorax; surface finely alutaceous dorsally, less so on gular surface; dull black without trace of pattern; surface very shallowly, broadly depressed behind fork of ecdysial suture; surface immediately before this junction transversely elevated as broad, medially depressed, smooth, shining "V"; behind extremity of each ecdysial sutural branch, flat, ocelluslike spot visible, but these lack ocellar structure. Clypeus with complete, deep suture between the tentorial pits; medial area flat, or shallowly depressed; anteclypeal and labral membranes dull smoke-black. Eyes black, shining. Antennal segments glossy black except for four white distals with amber extremities; terminal segment apically gray; 24-segmented; segments elongate, rounded distad, narrowly tapered caudad, membranes purple-black; setae erect, elongate, wavy. Mandibles piceous, rugose; form as figured. Other mouthparts blackish-brown. Submentum form as figured, piceous with a deep, broad, elongate depression on each side; all margins strongly reflexed and elevated. All sclerotized portions of thorax and legs, including first acrotergite, uniformly black, shining except on alutaceous surfaces; all membranes dark gray-white, scarcely contrasting with sclerites. Dark areas of wings blackish-brown with bluish luster, all margins dark; hyaline intervals narrow, cross-veins white only when crossing these intervals. All sclerotized portions of abdomen, including terminalia and cerci, shining jet-black; membranes and medial areas of eighth and ninth terga purple-black. Dimensions (freshly killed): Body length 18.5 mm; fore wing length 11.5 mm, breadth 2.9 mm.

Important anatomical characters (Fig. 7): flat clypeus; obtuse, rather than acute left mandibular flange between apical dentation and molar cusp; narrow, well-defined, left tergal process (10 LP) with abruptly membranous tip; acute right process (10 RP); detached epiproct sclerite.

NEOALLOTYPE.—Female with neotypic data and disposition.

DESCRIPTION.—Large, robust. All sclerotized dorsal surfaces glossy blackish-brown with faint purple luster except for dull, alutaceous black cranium with faint mahogany "cloud" between eyes. Antennal coloration parallels that of males. Most body membranous areas dull, dark lavender, appearing concolorous with sclerites to unaided eye. However, some dorsal membranous areas whitish in consistent pattern as follows: white dorsocoxal membrane of forelegs; transverse yellow-white band across front margin of meso- and metascuta, forming two prominent pale thoracic bands; dorsopleural areas of first eight abdominal segments abruptly white, combining to form white line down each side of abdomen. Mid and hind coxae and trochanters pale yellow; terminal segments of cerci gray-tan. Ventral sclerites of body clouded with medium brown. Body length 27.5 mm.

PARANEOTYPES.—Hundreds of adults reared in type culture; deposited in AMNH, BMNH, CAS, ICNB, IZAM, MIUP, and USNM.

ADDITIONAL RECORDS.—Colombia: 5 mi (8 km) E El Colegio, Cundinamarca, 1370 m, 9-III-55 (ROSS); 18 mi (29 km) W Honda, Caldas, 820 m, 16-III-55 (Ross).

DISCUSSION.—*Antipaluria aequicercata* is probably confined to tropical forests of the western drainage of Colombia. A closely related species, described below, occurs in rain forest of eastern Panama. These two species can most readily be distinguished from other congeners by their slender, well-formed left tergal process.

BIOLOGY.—*Antipaluria aequicercata* produces conspicuous silk galleries on tree trunks, stumps, and other surfaces in mountain rain forests. Much of this zone in Colombia is devoted to coffee production. Several other embiid species also occur on residual trees, stumps, and fence posts in coffee plantations. In culture, males of *A. aequicercata* mature almost every month of the year. Because of the abundance of the species, it seems safe to conclude that Moritz's type specimen, labeled "Colombia," was collected in one of the easily accessible coffee regions of the country. This seems to justify the present choice of a neotype from a coffee-growing locality. The specimen described by Ross (1944) closely resembles the neotype and is from the neotype region. However, its exact origin is uncertain because it was collected at a U.S. port among orchids in plant quarantine shipped from Medellín, Colombia.

Antipaluria panamensis Ross, new species
(Figure 7a)

HOLOTYPE.—Male, on slide, CAS. Data.—Panama: 10 km N El Llano, Panama 1300′ elev., matured in culture 17-XII-76 (Ross).

DESCRIPTION.—Appearance: Large, relatively

slender; blackish-brown throughout, including membranous areas, except for white-tipped antennae and lavender wing luster. Color (in alcohol) and anatomical details: Cranium rather small, narrow, caudally tapered; vertex between eyes with two raised, amber elevations; surface otherwise alutaceous, dull blackish-brown clouded with mahogany. Clypeus transversely depressed; anterior margin straight, inflexed, sclerotic. Antennal segments elongate; bearing long, erect, wavy setae; blackish blending to dark mahogany; segment XXI tan, blending distad to cream; XXII–XXIV whitish, the terminal (XXV) white, tipped with brown. Palpi concolorous with antennal bases. Submentum translucent mahogany, short, broad; broadly depressed on each side. Prothorax narrower than cranium across eyes; pronotum dark mahogany with paler areas along lateral margins and sutures; all other sclerites, including cervicals, dark mahogany; all membranes dark lavender, not contrasting with tone of sclerites. All other body sclerites and legs various shades of mahogany-brown with dark lavender membranes, appearing unicolorous black to unaided eye. Wings very dark, almost black, hyaline intervals narrow with diffuse margins; wing margins dark; cross-veins with white portions small, indistinct; setae relatively long. Terminalia very similar to *A. aequicercata* especially in narrow, definite form of 10 LP; 10 RP, however, shorter and much less acute. Dimensions (on slide): Body length 16.5 mm; fore wing length 11.7 mm, breadth 2.6 mm.

ALLOTYPE.—Female, in alcohol, with same data and disposition as holotype.

DESCRIPTION.—Larger and more robust than males. Very similar to females of *A aequicercata* but smaller and less robust with body sclerites more blackish and apparently with greater purple luster. Transverse, pale, thoracic bands whiter and less broad (especially that associated with mesonotum). Body length: 21.0 mm.

PARATYPES.—Numerous adults reared in type culture. Deposited in AMNH, BMNH, CAS, ICNB, IZAM, MIUP, and USNM.

DISCUSSION.—*Antipaluria panamensis* is closely related to *A. aequicercata,* but males are distinct in many minor characters such as the following: smaller size and more slender proportions, especially the elongate cranium; the left mandible bears an acute projection between the dentation and its proxadental cusp (a broad, low flange in *A. aequicercata*); broader, shorter submentum; the tenth tergal processes are less sclerotized in *A. panamensis,* 10 RP being much shorter and broader. Females may be distinguished by characters mentioned in the neallotype description.

The occurrence of a clothodid on the isthmus of Panama was unexpected. During October, 1976, after much search in the low, virgin rain forest at the type locality, I found only two colonies. Each was the brood of a single female that produced a conspicuous labyrinth of fully exposed, white galleries on the trunk of a small tree. During December 1976, nymphs were penultimate, and most males and females matured in culture during January, 1976, and as late as March. No second brood was reared because of a *Diplocystis* infestation. I am indebted to Dr. Lynn Siri Kimsey, who collected a female of this species on 3-IV-74 and thus called my attention to its occurrence, and to Dr. Robert Dressler for taking me to Dr. Kimsey's collection site.

The Urichi Group

Antipaluria urichi (Saussure), new combination
(Figure 8a)

Embia urichi Saussure, 1896*a*:293.
Olyntha urichi (Saussure) Krauss, 1911:29, pl. 1, fig. 2, 2a (ex parte, included potential type of *A. aequicercata*).
Antipaluria urichi (Saussure) Enderlein, 1912:64.—Navás 1918:106.
Clothoda urichi (Saussure) Davis, 1939:377, fig. 17–21; 1942:111, fig. 1–5.—Ross 1944:406, fig. 8.—Mc. C. Callan 1952:483.—Kirkpatrick 1957:79, 267.
Embia uhrichi Saussure (*lapsus calmi*), 1896*b*:350.—Melander 1903:103, fig. 2c.—Friederichs 1906:238.—Kershaw 1914:24, pl. 3, 4 (embryology).

Cotypes.—Pinned males, Muséum d'Histoire Naturelle, Geneva. Data.—"Insula Trinitaris (Antillae), a Dom. Uricho lecta" (probably Port of Spain).

DISTRIBUTION.—This species is common throughout Trinidad, where its colonies are especially conspicuous on trunks of shade trees in settled areas. It also is sporadically distributed on trees, stumps, etc., in natural forest. For the present, it is best to regard the species as limited to Trinidad. Specimens from Caracas, Venezuela, determined as *Clothoda intermedia* Davis, 1939, and later identified by him (1942) as *urichi,* represent a distinct species.

RECOGNITION.—Any clothodid found in Trinidad may be considered to be *A. urichi.* Adult males differ from those of all known Venezuelan species by their very flat clypeus with a straight an-

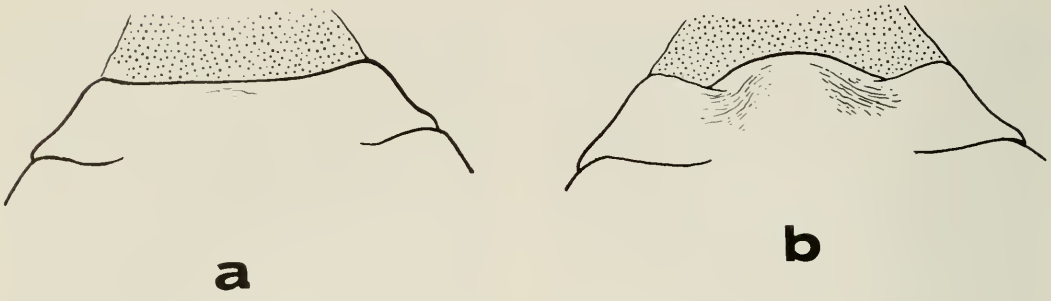

FIGURE 8a. *Antipaluria urichi* (Saussure). Clypeus of male from Trinidad. Figure 8b. *Antipaluria intermedia* (Davis). Clypeus of topotypic male.

terior margin (Fig. 8a). It is probable that *A. urichi* occurs naturally on adjacent shores of Venezuela, and there is always the possibility that its range has been extended by human commerce. Numerous Trinidad records in the literature and in my collection (CAS) need not be cited because of the small size of the island.

This species has been the subject of recent, intensive, behavioral studies by Janice Edgerly.

Antipaluria intermedia (Davis), new combination (Figure 8b)

Clothoda intermedia Davis, 1939:376, fig. 8–16; 1942:112 (as syn. of *A. urichi*).

Clothoda urichi intermedia (Davis), Ross, 1944:408, fig. 6, 7, 9, pl. 18, A.—Mc. C. Callan 1952:483.

HOLOTYPE.—Male on pin (damaged in transit to museum), BMNH. Data.—Venezuela: Caracas (Dr. Ernst).

DISCUSSION.—In the British Museum I located a few adult males of *A. intermedia,* in alcohol with type data, which apparently were not studied by Davis. One of these specimens is now in CAS by exchange.

On the basis of previously overlooked characters, it is apparent that *A. intermedia* is distinct from *A. urichi* of Trinidad. Most significant, as shown in Figure 8b, is the strongly vaulted, glossy, piceous-black medial area of the clypeus (flat in *A. urichi*) and consequent bi-emarginate anterior clypeal margin (straight in *A. urichi*). My Ernst specimen is large (body length 20.5 mm), robust, and all sclerites are uniformly brown (probably lightened from blackish-brown by long preservation in alcohol). Inasmuch as the following two closely related new species demonstrate that coloration characters are consistent, it would be desirable to study the coloration of freshly collected specimens from Caracas.

For the present, males of the following three species can be superficially distinguished by pronotal and cervical coloration. That of *A. intermedia* apparently is uniformly dark brown; *A. silvestris* has blackish cervical sclerites, and the posterior third of the otherwise dark pronotum is yellowish whereas all cervical and prothoracic sclerites of *A. caribbeana* are golden. Such coloration is consistent in hundreds of males. Probably there are also reliable anatomical characters; for example, the left mandible of *A. silvestris* is more deeply emarginate on either side of the medial flange and the clypeus is not as prominently domed as in *A. intermedia.*

Antipaluria silvestris Ross, new species

HOLOTYPE.—Male, on slide, CAS. Data.—Venezuela: 10 km N Rancho Grande (near Maracay). 8-III-75 (Ross).

DESCRIPTION.—Appearance: Large, slender; all sclerotic surfaces blackish except for golden-brown posterior third of pronotum; cervical and prothoracic membranes white, other body membranes dark lavender except for whitish dorsopleural abdominal membranes; four apical antennal segments abruptly whitish. Color (in alcohol) and anatomical details: Cranium small, elongate, jet black, dull; postocular surface depressed; interocular ridge dark, glossy. Clypeus rugose, transversely strigose medially on a surface which is broadly elevated; anterior margin weakly arcuate. Antennal segments mostly globular with short, straight setae. Eyes almost as dark as cranium. Sclerotized portions of mouthparts only slightly lighter than cranium; submentum rugose, deeply foveate. Cervical sclerites very dark brown, membranes white. Pronotum blackish-brown but blending at about caudal third from golden-brown to amber-yellow; anterior mem-

branous margin narrowly yellow; other prothoracic sclerites blackish-brown. Sclerotized portions of body and legs various shades of dark brown, thoracic scuta clouded with golden-brown; all such surfaces reflecting a bluish luster. Tenth tergal processes fleshy, strongly curled dorsad; inner sides membranous. Epiproct sclerite very slender. Terminalia generally similar to that of *A. caribbeana*. Dimensions (on slide): Body length 15.0 mm; fore wing length 11.0 mm, breadth 2.75 mm.

ALLOTYPE.—Female, in alcohol, with holotype data and disposition.

DESCRIPTION.—Essentially as in *A. aequicercata* but with distinct distribution of white in membranous regions of body as follows: all dorsal, intersclerotal membranes white except those anterior to the thoracic scuta, and the pleural and sternal membranes, which are lavender (thus the characteristic, transverse prescutal white bands of *A. aequicercata* are absent); membrane above forecoxae dark lavender. Apical segments of cerci and most of mid and hind coxae, golden-tan. Body length: 20 mm.

PARATYPES.—Many adult males and females reared in holotype culture. Deposited in AMNH, BMNH, CAS, ICNB, IZAM, MIUP, and USNM.

DISCUSSION.—Males of this species may be recognized by their slender body form, dark coloration, and especially, by the bicolorous pronotum (blackish with posterior third blending to yellow). The fact that the species was collected only a few kilometers inland from the habitat of *A. caribbeana* suggests that many additional species of *Antipaluria* will be discovered as northeastern South America is thoroughly searched for embiids.

The type culture was collected on a vegetation-draped rocky roadbank in high, tropical cloud forest a short distance north of the crest of the pass between Maracay and Ocumare de la Costa (10 km N Rancho Grande). The vegetation was distinct from that of the deciduous thorn forest habitat of *A. caribbeana*. There is also approximately a 700-m difference in altitude between the two type localities.

Antipaluria caribbeana Ross, new species

HOLOTYPE.—Male, on slide, CAS. Data.—Venezuela: near Ocumare, inland from Turismo, almost at sea level. Matured in culture 10-VII-75 (Ross).

DESCRIPTION.—Appearance: Large, robust; blackish-brown throughout with faint bluish luster except for the yellowish prothorax and white antennal apices. Cranium oval, eyes exceptionally small and forward. Clypeus very short, abruptly slanted ventrad; medial area vaulted, heavily sclerotized, jet black, glossy, transversely striated; anterior margin arcuate. Cranial surface dull piceous except for small golden area between eyes which is elevated as small, transverse, glossy ridge. Gula pale amber, glossy. Antennae entirely dark except for four whitish apical segments, most basal of which is pale tan; setae rather short and somewhat recumbent. Submentum slightly produced at apical angles; basal angles deeply foveate, apparently containing residue of whitish secretion. Sclerites of prothorax and cervix amber-yellow, tinged, especially along sutures, with brown; all adjacent membranous areas cream-white. Remainder of body and appendages piceous-brown with bluish luster. Numerous white cross-veins in wings. Terminalia similar to *A. urichi* but with inner side of 10 LP more extensively membranous; 10 RP shorter, less acute, apex rounded. Segments of cerci shorter, more robust. Dimensions: Body length 17.0 mm; fore wing length 11.0 mm, breadth 2.6 mm.

ALLOTYPE.—Female, in alcohol, with data and disposition same as the holotype.

DESCRIPTION.—Much larger than males. All sclerotized areas blackish-brown and all membranous areas whitish. Cranium with large, transverse golden-brown area between eyes occupying at least one-third surface of head. Antennae dark brown except for four, entirely white, distal segments. Prothoracic and cervical sclerites dark brown, pale ventrally, associated membranous areas whitish, subcutaneously lavender at sides and ventrally. All other body segments similar in coloration except posterior pronotal plate and lighter brown legs; dorsopleural membranes of thorax with pure white, subcutaneous, fat globules resulting in dorsopleural stripe running almost full length of each side of body. Tarsi becoming light brown. Body length 24.0 mm.

PARATYPES.—Hundreds of topotypic, culture-reared males and females in AMNH, BMNH, CAS, ICNB, IZAM, MIUP, and USNM.

DISCUSSION.—*Antipaluria caribbeana* eventually may prove to be but a subspecies of poorly known *A. intermedia* from the Caracas region. Males of the two species have in common the small-eyed, oval cranium; the complex clypeus; the deeply foveate submentum; and much else. Although the type localities of the two species are

in the same general region, it is assumed that altitudinal and ecological differences (Caracas region, above 1000 m and Ocumare near sea level) would be reflected in at least subspecific differences in many components of the respective biotas. For the present, *A. caribbeana* is immediately recognizable by the contrasting pale color of the prothorax and cervix.

Biology.—The type cultures of *A. caribbeana* were collected in conspicuous galleries spun on surfaces of rocky road banks. Each colony consisted of a single female and her brood of nymphs that had found refuge from desiccation and predation in galleries penetrating rock cracks.

The small hills and canyons of the Ocumare environment are clothed with a dense tangle of large trees, thorny shrubs, and lianas. During my visit in March, the weather was dry, and thus most of the vegetation was leafless. Adults matured in cultures during July, and by the first of August oviposition began. The egg masses were large and single layered. Toward the end of August, nymphs began hatching, and adults of these broods matured during April and May of the following year. It is thus likely that the species has only one brood per year.

The Marginata Group

Antipaluria marginata Ross, new species

Holotype.—Male, on slide, CAS. Data.—Colombia: 3 mi (5 km) W of Villavicencio, Meta, 920 m, III-55 (Ross).

Description.—Appearance: Large, robust; dull dark mahogany throughout (including entire antennae) except for cream-white membranous areas of body and whitish costal and anal margins of wings. Anatomical and color (in alcohol) details: Cranium relatively small, elongate, sides straight; surface finely alutaceous dorsally, smooth ventrally, pattern obsolete; with two glossy foveae between eyes. Clypeus transversely striate, glossy; medial area vaulted; anterior margin bi-emarginate. Eyes rather small, forward in position. Antennae, including membranes, uniformly dark brown to apex; flagellar segments globose, 24 in number; setae rather short, curved, not wavy. Mandibles glossy piceous with dark amber areas; left mandible with an acute tooth between apical dentation and molar cusp. Submentum largely yellow-amber, piceous anteriomedially; very deeply foveate in caudal angles. All sclerotized portions of body and legs uniformly dark brown except for pale posterior pronotal plate and pale femur-tibial joints of mid and hind legs; all membranous areas cream-white except for dark lavender tones of ventral pterothoracic membranes. Wings with pigmented areas dark brown, without bluish luster; costal margin, especially in basal half, translucent cream-white; hind margin whitish between base and apex of cubital sinus; cross-veins numerous, white when crossing hyaline intervals. Dimensions: Body length 17.0 mm; fore wing length 12.0 mm, breadth 2.85 mm. Terminalia: Broad, cerci stout, basically similar to those of *A. aequicercata* but with processes, especially 10 LP, less distinctly formed, somewhat fleshy, thick and short; epiproct sclerite (EP) detached, short, side margins obtusely angled; surface between tenth hemitergites and processes less depressed.

Allotype.—Female, in alcohol, with same data and disposition as the holotype.

Description.—About size of average male. Coloration similar to that of males but with a suffused, golden-brown, transverse area between eyes; antennae distinct due to five whitish apical segments (23 segments total). Body length: 17.5 mm.

Paratypes.—Twenty-five topotypic adult males in CAS, ICNB, and USNM.

Records.—All specimens were collected in the vicinity of Villavicencio (3 mi [5 km] W at 920 m; 8 mi [13 km] W at 1150 m; and 4 mi [6 km] SE at 410 m). Unfortunately, only a small series of adults was reared from these lots. Adult males appeared in culture between March and December; there is probably no definite period of peak maturation.

Discussion.—*Antipaluria marginata* males may be distinguished at a glance by their white-bordered wings (similar to those of *Clothoda nobilis*) and the entirely dark antennae (no white tips). It is the only species of *Antipaluria* known from east of the Andes in Colombia. Related species are almost certain to be discovered as the eastern portions of Colombia are explored.

Antipaluria marginata is very common in the vicinity of Villavicencio and its galleries cover roadside fence posts, stumps, logs, and tree trunks so extensively that they can be seen from a moving vehicle. *Antipaluria marginata's* colony structure and habits are very similar to those described for *Clothoda longicauda.*

Chromatoclothoda Ross, new genus

Type Species.—*Chromatoclothoda elegantula* Ross, new species.

Distribution.—Amazon basin.

Diagnosis.—Males: Small to large (body

length 9.3–15.5 mm). Body multicolored; prothorax, and at times entire thorax, yellow or orange; antennae and cerci often with distal segments white. General form more slender than that of other clothodids. Mandibles varying from stout *Clothoda* type to delicate, thin oligotomoid type; gula without setal clumps. Prothorax not exceptionally broad. Wings narrow with anal area strongly tapered and reduced; pigmented venal bands paler than in other clothodid genera with costal and RBS borders brighter pink, or red; all wing veins strongly cuticularized almost to apices; fork of MA more distal than in most clothodids; MP and CuA always unbranched; relatively few cross-veins. Hind basitarsi with two ventral papillae, medial one at times small. Abdominal terminalia generally as in *Antipaluria* but with mesocaudal angle of left hemitergite membranous and produced as a very short process, or not at all; right process (10 RP) scarcely produced. Ventral structures and cerci as in *Antipaluria.* Apical segments of cerci often contrastingly pale.

Females: Without important generic characters but differing from other clothodids in having the body surface very glossy, luster at times metallic. Antennal apices, and often apical segments of cerci, white.

Discussion.—*Chromatoclothoda* is a very interesting genus with increased specialization of characters, especially of the head, wings, and terminalia. The terminalia structure is closer to that of *Antipaluria* and *Cryptoclothoda* than to *Clothoda,* but the biology is strikingly distinct from that of these genera. Colonies are established on sheltered tree bark, especially undersides of horizontal tree branches, and rock ledges; colonies usually consist of long galleries that are apparently used repeatedly by successive generations. This is evidenced by the density and whiteness of the silk walls resulting from a long accrual of silk, layer on layer. The outer surfaces of such galleries are coated with finely pulverized bark or fecal material on which a cover of lichens or fine moss may grow. As a result, the colonies are very difficult to find. *Chromatoclothoda* egg masses are more sparsely enclosed in masticated material than those of *Clothoda* and *Antipaluria.*

Component Species.—Five new species have been collected in the Amazon drainage of Peru, Ecuador, Colombia, and Brazil. When other localities are visited, very careful search for the cryptic colonies should bring to light many additional species.

Key to Species of *Chromatoclothoda*
Adult Males

1. Apical segments of cerci white. Hemitergites of tenth abdominal segment without distinct processes 2
— Cercus segments uniformly dark. Hemitergites with small but distinct processes 4
2. Thorax entirely golden. Peruvian drainage of Amazon and middle Amazon basin 3
— Prothorax golden, pterothorax dark brown. Ecuadorian and Colombian tributary region of Amazon basin ..... *albicauda*
3. Sides of submentum feebly arcuate, gradually convergent anteriorly; anterior margin shallowly emarginate (Fig. 9). Coxae and trochanters as dark as other leg segments. Manaus region, Brazil ..... *elegantula*
— Submentum sides strongly arcuate; anterior margin narrowly and deeply emarginate (Fig. 9a). Coxae and trochanters of all legs golden. Tingo María region, Peru ... *aurata*
4. Larger species (body length 13 mm). Antennal apices dark. Upper Rio Perené, Peru ... . *nigricauda*
— Smaller species (body length 9 mm). Antennal apices pale. Huánuco region, Peru..... ..... *nana*

Chromatoclothoda elegantula Ross, new species
(Figure 9)

Holotype.—Male, on slide, CAS. Data.—Brazil: Reserva Ducke, 10 km N Manaus, Amazonas; matured in culture 14-VIII-64 (Ross).

Description.—Appearance: Medium sized (body length 13 mm), winged; blackish except for brilliant orange thorax, white-tipped antennae and distal segments of cerci. Color details (in alcohol): Cranium entirely piceous, almost black, except for suffused golden-brown gula and margins of occipital foramen. Eyes dark purple, tone paler than that of cranium; margins narrowly golden. Antennal segments I–XIV concolorous with cranium, with wavy piceous setae; segment XV apically gray; segments XVI–XX, including setae, white. Mandibles basally piceous, blending distad to dark red-amber; submentum red-amber; palpi and labrum blackish-brown, other mouthparts golden. Cervical and thoracic sclerites brilliant orange with contrasting blackish setae, all thoracic membranes concolorous with sclerites; mesospinasternum clouded with dark gray. Forecoxae and midcoxae basally yellowish, blending distad to black; hind coxae entirely black; all other leg

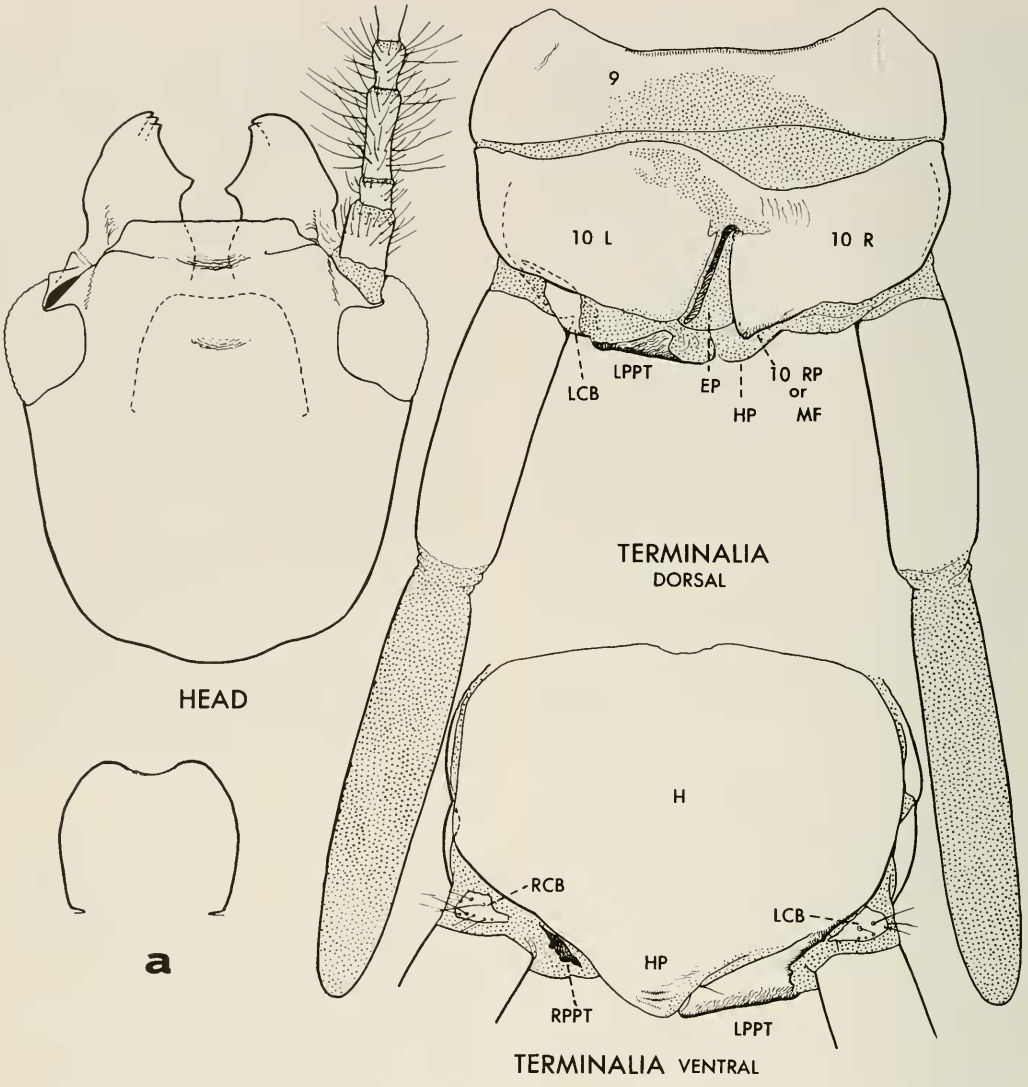

FIGURE 9. *Chromatoclothoda elegantula* Ross, new species. Head and terminalia of holotype. For an explanation of symbols see page 10. Figure 9a. *Chromatoclothoda aurata* Ross, new species. Submentum of holotype.

segments black. Wings richly pigmented; all longitudinal veins broad and dark; venal bands dark gray-brown; hyaline intervals light gray with weak margins; RBS borders brick-red. All abdominal sclerites blackish-brown with distal, submembranous band of each segment mottled rust-red; sclerotic areas of ninth and tenth segments darker, associated membranes tan, tinged with rust-red; apices of hemitergites as dark as bases, epiproct sclerite red-brown. Basal segments of cerci dark brown with membranous extremities rust-red; distal segments snow-white especially so because of white internal tissue, setae pale amber. Dimensions (on slide): body length 13.0 mm; fore wing length 8.0 mm; breadth 1.7 mm.

Important anatomical characters (Fig. 9): wings smaller and narrower than in closest relative, *C. aurata*; veins more heavily marked, MA branched well distad of midpoint; fewer crossveins between Rs and MA. Terminalia processes

not developed; inner margin of right hemitergite more sharply defined and sclerotized than in *C. aurata*. Epiproct sclerite (EP) very slender, narrowly linked to right hemitergite. Distal segments of cerci longer than basals and not sclerotized.

ALLOTYPE.—Female, in alcohol, with holotype data and disposition.

DESCRIPTION.—Appearance: Moderately large, cylindrical; glossy, jet-black except for white antennal apices and gray-white band across dorsum of joint between meso- and metathorax. Color details: Cranium dull, alutaceous blackish-brown suffused with golden-brown around anterior tentorial pits, sides of clypeus, and gula. Antennae 20-segmented, blackish except for 4 white apical segments. Prothoracic sclerites rather dull black with faint glint of dark blue, dark chestnut-brown ventrally, membranes lavender. Meso- and metathorax similar except for more dull texture of scuta and white membranes dorsally between segments. All legs concolorous with thorax but with anterior tarsi red-mahogany. Abdominal sclerites dark mahogany with surface smooth, shining, luster faintly greenish, intersegmental areas more reddish; all membranes purple. Sterna VIII and IX without unusual features. Cerci with basal segment dark, apical segment blending distad from medium brown to tan. Body length: 11.0 mm.

PARATYPES.—Numerous topotypic males and females. Adults matured in cultures between July and September. Deposited in CAS, USNM, BMNH, MNR, and MZSP.

DISCUSSION.—*Chromatoclothoda elegantula* of the middle Amazon is very closely related to *C. aurata* occurring in the Peruvian tributary region of the Amazon River, along Río Huallaga, near Tingo María. As series from intermediate localities become available, it is possible that *C. aurata* will prove to be indistinguishable. *Chromatoclothoda elegantula* can at present be separated from *C. aurata* by its more slender, elongate antennal segments (length four to five times longer than diameter); its submentum is broadest across the base and the sides are not evenly arcuate, and the inner margin of 10 RP is sharply defined (vague and submembranous in *C. aurata*).

BIOLOGY.—The type culture was propagated from several colonies found in the bark of large trees scattered in a small, roadside farm and from one colony in bark in virgin forest. The galleries were almost completely obscured by debris and a growth of lichens and moss. The silk of old galleries was very dense and white but freshly spun silk was quite transparent, lavender in tone, and finely dusted with pulverized fecal pellets.

Chromatoclothoda aurata Ross, new species
(Figure 9a)

HOLOTYPE.—Male, on slide, deposited in CAS. Data.—Peru: 5 mi (8 km) SW of Las Palmas (near Tingo María), Huánuco, about 1000 m, matured in culture 5-XII-54 (Ross).

DESCRIPTION.—Appearance: Large, very similar to *C. elegantula* but much larger; dark mahogany-brown with entire thorax golden-yellow; antennal and cercus apices white. Color details (in alcohol): Cranium very dark mahogany-brown with faint dorsal pattern; ventrally dark chestnut-brown. Eyes blackish-lavender, rimmed with golden-brown. Basal segment of antenna concolorous with cranium; segments II–XVI mahogany-brown; segment XVII basally tan, otherwise cream-white, segments XVIII–XXI pure white (segmentation complete). Mandibles piceous-brown; submentum similar, other mouthparts medium brown. Thoracic and cervical sclerites basically pale yellow, furca and basisterna paler; dorsal sclerites, especially pronotum, tinged with golden-brown; thoracic setae contrastingly dark brown; all thoracic membranes cream-white. Coxae of all legs pale yellow, trochanters tan, all other segments red-mahogany. Abdominal sclerites medium to dark brown; membranes gray-lavender, segments nine and ten and basal segments of cerci dark mahogany, the latter with dark lavender membranes at extremities of segment; distal segments of cerci pure-white with pale amber setae. Dimensions (on slide): Body length 17.5 mm; fore wing length 11.0 mm, breadth 2.75 mm.

Important anatomical characters: Very similar to *C. elegantula* but with minor distinctions, for example, antennal segments shorter (length less than three times segment diameter); submentum with evenly arcuate sides, broadest across middle; molar cusps of mandibles obtuse, less pronounced; inner margin of 10 RP weak, submembranous.

ALLOTYPE.—Female, in alcohol, data and disposition same as holotype.

DESCRIPTION.—Smaller than males. All sclerotized surfaces blackish-brown, body glossy, antennal and cercus apices white, pale band across apices of meso- and metathoracic scuta. Cranium dull, dark mahogany-brown with red-mahogany clouding between eyes and around tentorial pits. Eyes almost concolorous with cra-

nium. Antennae with segments I–XVII blackish-brown, XVIII blending to medium brown; remaining 5 segments cream-white, becoming paler distad. Legs glossy, blackish-brown, apices becoming dark tan. Most intersclerite membranes dark lavender except whitish dorsally between thoracic segments. Basal segments of cerci black, apicals whitish-tan. Body length 15.0 mm.

Paratypes.—Three topotypic males and 28 adult females. Also, 30 males and 26 females from Cueva de la Pava, near Tingo María, Huánuco, Peru; matured in cultures between 10-IX and 24-XI-65 and 1 pair III-66, (Ross). Paratypes deposited in CAS, BMNH, and MHNP.

Additional Record.—Peru: W end Boquerón de Padre Abad, Cordillero Azul (E Tingo María) 1 male matured III-24-55 (Ross).

Biology.—Matted galleries occur on the underside of slanted tree trunks, large and small, especially along margins of streams and in dark, shaded habitats.

Chromatoclothoda albicauda Ross, new species
(Figure 10)

Holotype.—Male, on slide, deposited in CAS. Data.—Colombia: Mocoa, Nariño, 700 m, 2-III-55 (Ross).

Description.—Appearance: Moderately large, winged; mahogany-brown with yellowish prothorax and white-tipped antennae and cerci. Color details (in alcohol): Cranium uniformly dull, dark mahogany-brown; lacking pattern; ventral surface and gula slightly paler. Eyes dark purple, margins narrowly golden. Basal antennal segment concolorous with cranium; segments II–XIII medium mahogany-brown, vestiture brown; XIV basally tan, apical two-thirds cream; XV–XIX white (antennae complete), vestiture white. Mandibles piceous-brown; submentum amber basomedially, otherwise varied shades of mahogany-brown to piceous; other mouthparts medium brown. Cervical and prothoracic sclerites basically yellow-brown; pronotum darker due to suffusion of golden-brown and dark brown setae; associated membranous areas cream-white. Pterothorax and abdomen mahogany-brown with piceous sutures; membranous areas purple-brown, same tone as sclerotic areas. All leg segments mahogany-brown except for yellow-brown fore coxae and trochanters; thoracic membranes mesad of hind coxae largely white. Wings medium brown, more or less concolorous with pterothorax and abdomen; hyaline intervals very narrow, margins well defined; all veins strongly cuticularized; cross-veins behind Rs white when crossing hyaline intervals. Sclerites of abdominal terminalia dark mahogany-brown, membranes rust-brown, apices of processes concolorous with hemitergites; basal segments of cerci, including their basal and distal membranes, dark mahogany-brown; distal segments white but with brown setae. Dimensions (on slide): body length 13.5 mm; fore wing length 9.5 mm, breadth 2.2 mm.

Important anatomical characters: Cranium elongate, sides parallel, abruptly rounded caudally. Mandibles with apical teeth close together, not clearly visible from dorsal aspect. Sides of submentum abruptly convergent distad. Left tergal process (10 LP) not produced, margins unsclerotized; right process (10 RP or MF) broadly acute, short. Other details as figured.

Allotype.—Adult female, in alcohol, with holotype data and disposition.

Description.—Coloration similar to *C. aurata* but lacking pale, membranous, dorsal band between pro- and mesothorax; however, such band present between meso- and metathorax. Membranous areas also pale around metascutum and abdominal tergum I. Basal segments of cerci very dark brown; distal segments medium brown, becoming pale distad. Body length 14.5 mm.

Paratypes.—Nineteen topotypic males and 15 females reared in type culture. Deposited in BMNH, CAS, ICNB, and USNM.

Additional Record.—Ecuador: 6 mi (10 km) W Mera, Napo-Pastaza VII-55 (Ross), deposited in CAS. Galleries on underside of rock ledge. Future studies may indicate that this population is at least subspecifically distinct from that of Mocoa, Colombia. Minor distinctions include paler wings due to broader hyaline intervals, a deep midclypeal fovea, and paler setae on the distal segments of the cerci.

Chromatoclothoda nigricauda Ross, new species
(Figure 11)

Holotype.—Male, on slide, CAS. Data.—Peru: Ridge above Colonia Perené, 18 mi (30 km) NE of La Merced, Junín. Matured in culture VI-55 (Ross).

Description.—Appearance: Moderately large, slender, alate; prothorax and dorsum of pterothorax bright orange, body and appendages otherwise blackish. Color details (in alcohol): Cranium jet-black throughout. Antennae black, grading distad to smoke-black; apical segments apparently not white (20 segments present, apparently complete); antennal setae wavy. Submentum piceous, palpi blackish-brown. Prothorax bright orange throughout with sclerite margins rust-brown. Fore coxae and trochanters similar in basal half blending to dark brown dis-

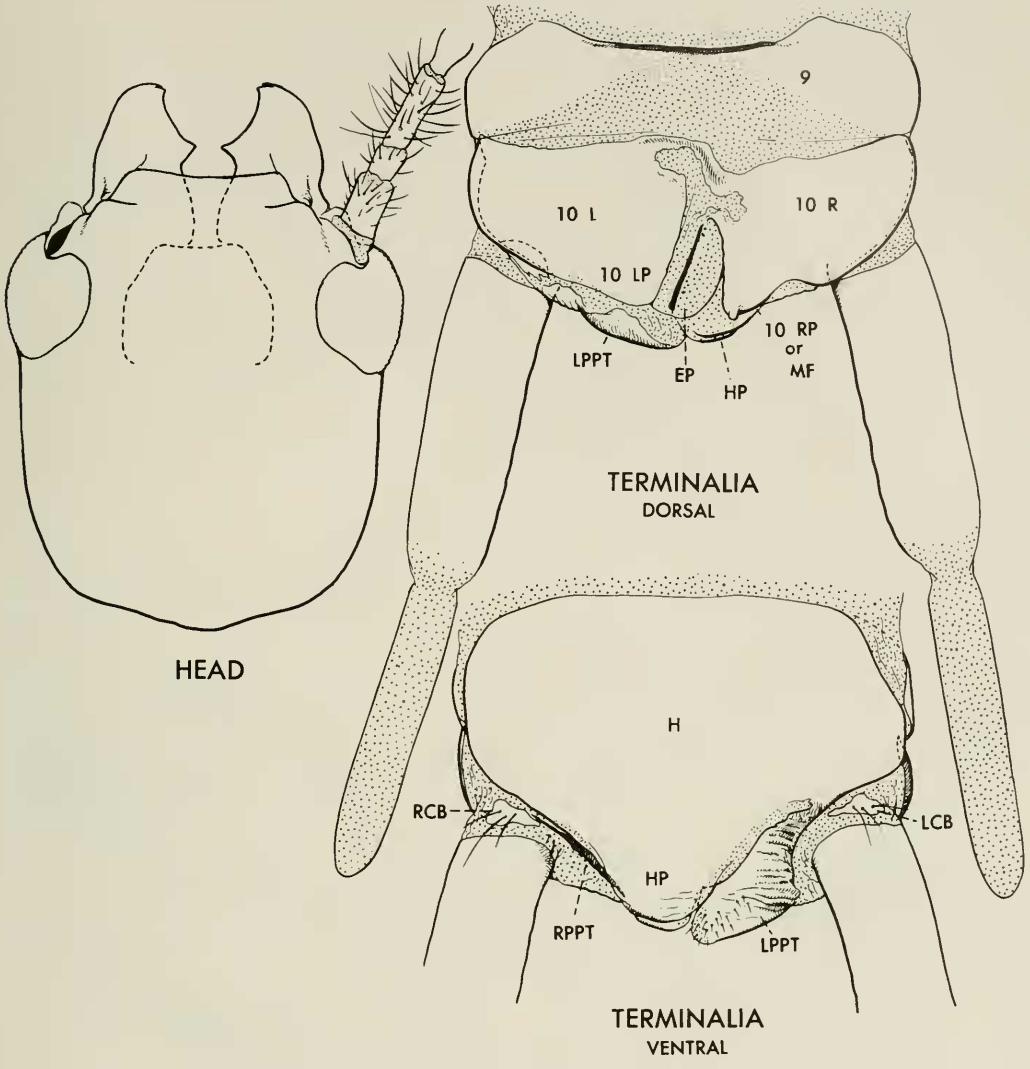

FIGURE 10. *Chromatoclothoda albicauda* Ross, new species. Head and terminalia of holotype. For an explanation of symbols see page 10.

tad; fore tibiae and tarsi piceous-black. Other legs similar but with tibiae and tarsi somewhat lighter. Pterothorax with scutae orange, margins and axillary cords rusty; pleurites and sternites dark brown. Axial area of wings orange. Abdomen dark piceous-brown with rusty membranes; terminalia sclerites and cerci piceous-black. Dimensions (on slide): Body length 11.7 mm; fore wing length 8.2 mm, breadth 2.0 mm.

Important anatomical characters: As in Figure 11.

Female: No specimens.

BIOLOGY.—The nymph of the holotype was found in chalk-white, dense, ribbonlike galleries amongst small vines on a dead stump in low, ridge-top forest. The galleries were inconspicuous due to a covering of fine debris.

Chromatoclothoda nana Ross, new species
(Figure 12)

HOLOTYPE.—Male, on slide, deposited in CAS. Data.—Peru: Yurac Plantation, 67 mi (108 km) E of Tingo María Huánuco, 14-XII-54 (Ross).

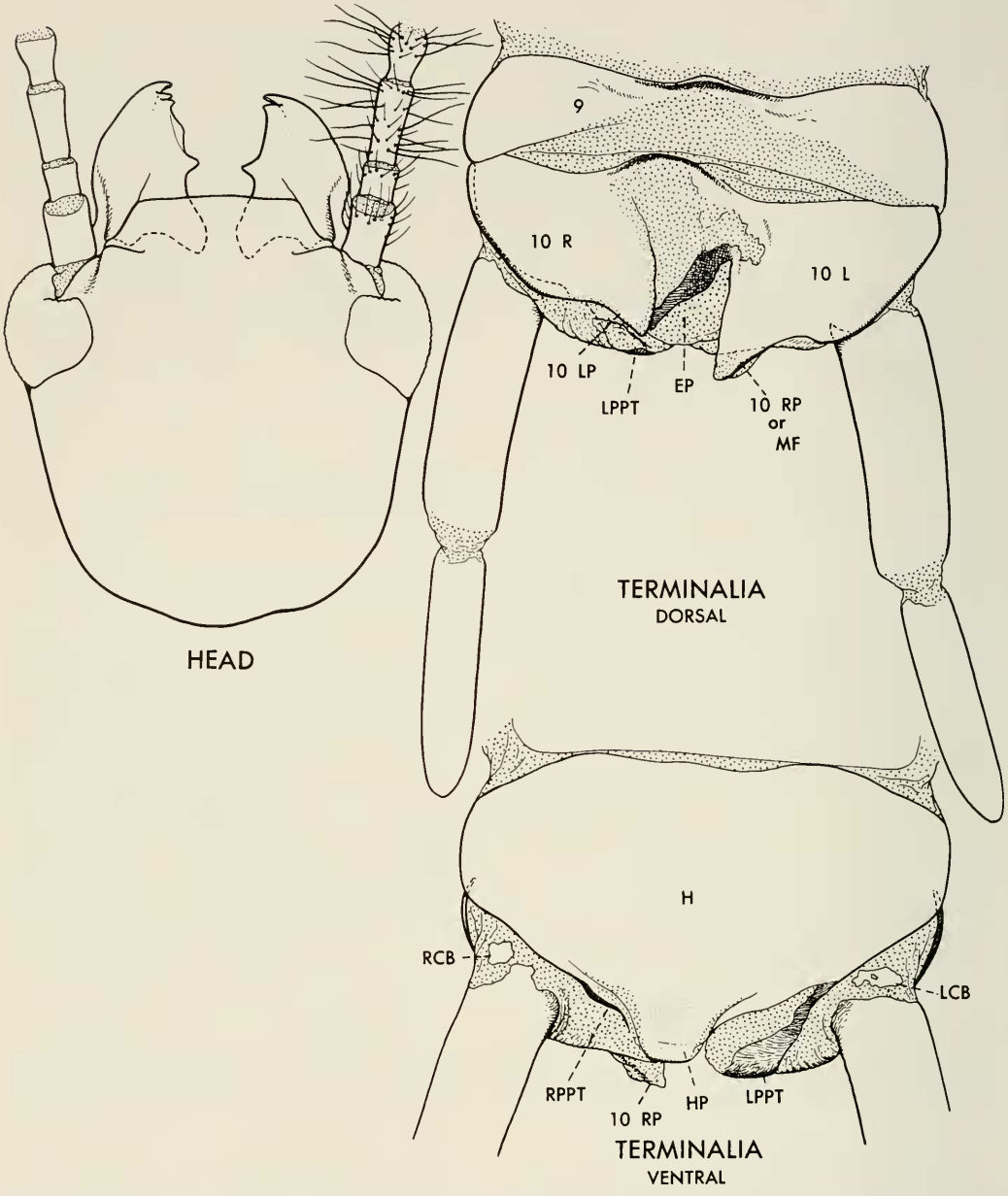

FIGURE 11. *Chromatoclothoda nigricauda* Ross, new species. Head and terminalia of holotype. For an explanation of symbols see page 10.

DESCRIPTION.—Appearance: Small for family, about size and appearance of *Oligotoma saundersii*; winged; thorax and legs largely yellowish; head, abdomen, and wings dark brown; cerci entirely brown; antennae white-tipped. Color details (in alcohol): Cranium mahogany-brown with faint, paler pattern; golden-brown ventrally. Eyes dark lavender with golden margins. Antennal segments I–XIII dark brown, basal segment not much darker than sub-basals; segment XIV basally brown, apical two-thirds pale amber; segments XV–XVIII white (segmentation complete), vestiture white. Mandibles dark mahogany-brown to amber-brown; submentum

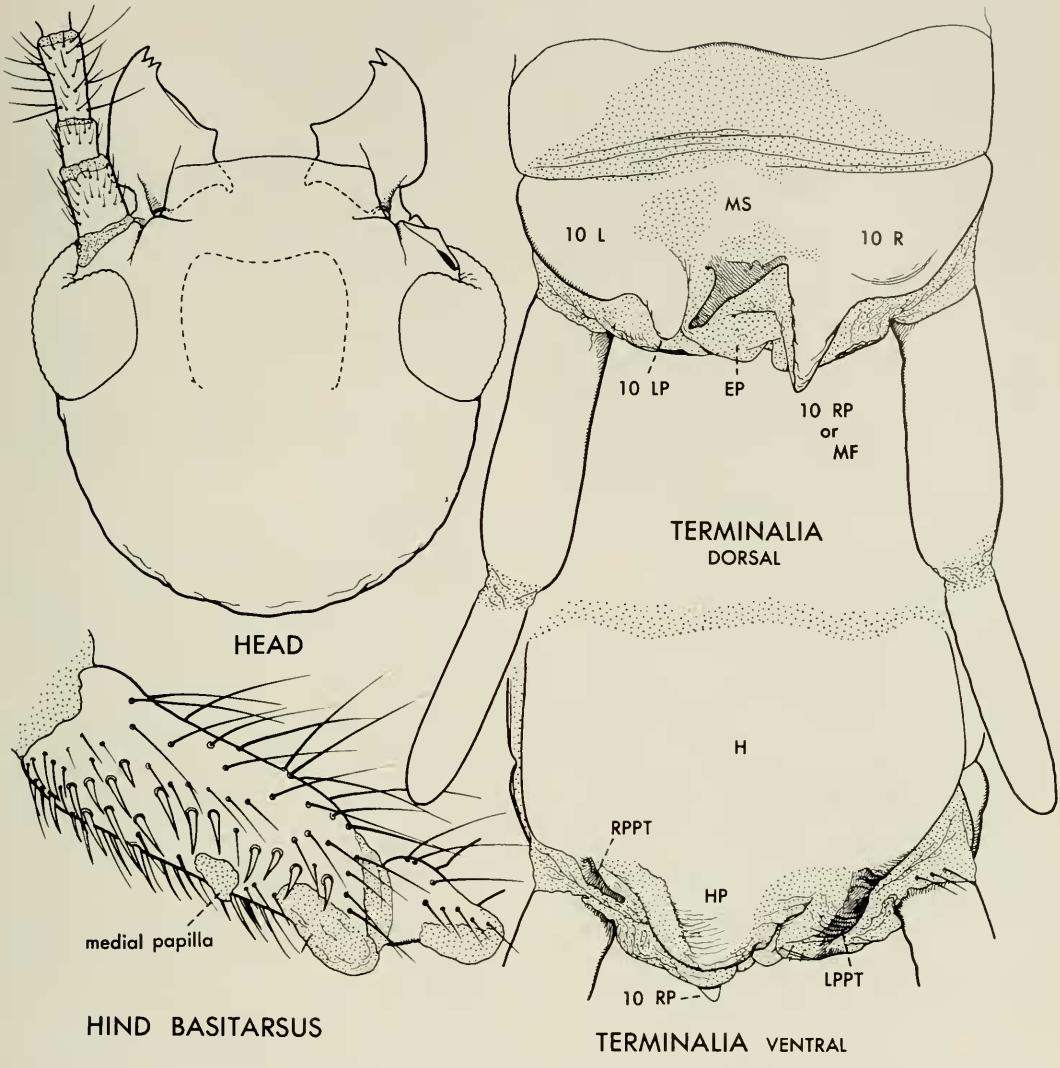

FIGURE 12. *Chromatoclothoda nana* Ross, new species. Head and terminalia of holotype. For an explanation of symbols see page 10.

golden-brown, concolorous with gula; palpi dark brown. Thorax basically pale, straw-yellow with piceous setae, membranes cream-white; lateral and anterior margins of pronotum and dorsal fold of cervix tinged with bright orange; margins and sutures of pterothorax chestnut-brown, caudal region of metathorax strongly tinged with rust-orange. Coxae and trochanters of all legs cream-yellow, femora blending to golden-brown, all tibiae and tarsi chestnut-brown. Wing pigmentation as in *C. elegantula* but lighter brown, with hyaline intervals more sharply defined. All abdominal sclerites, including those of terminalia as well as all cercus segments, red-brown; all abdominal membranes red-purple. Dimensions (on slide): Body length 8.5 mm; fore wing length 6.0 mm, breadth 1.4 mm.

Important anatomical characters (Fig. 12): Cranium circular in outline with irregular caudal margins. Eyes rather large. Antennal segments elongate; setae erect and wavy. Mandibles oligotomoid, dorsoventrally thin; apical teeth sharply

defined, acute. Submentum flat, smooth, longer than broad; sides and front edges inflexed; evenly, but not heavily, sclerotized. Wings with rather broad hyaline intervals. Hind basitarsi with few large plantar setae and small, medial, ventral papilla. Tenth abdominal tergite with basomedial area weakly and irregularly sclerotized; left process (10 LP) weak, rounded, thumblike; right process (10 RP) rather long, acutely triangulate, apex blunt. Epiproct sclerite prominent, relatively darkly pigmented, gradually broadened toward base. Lobe of ninth sternum (HP) medial; edges irregular; blending to membrane. Left paraproct (LPPT) attached basally to H, otherwise separated by wide membranous gap from HP, transversely striate, apically weak; right paraproct (RPPT) represented only by well-pigmented basal rudiment. Cerci equal, distal segments shorter than basals.

Female: No specimens.

Paratype.—One male with type data, CAS.

Discussion.—*Chromatoclothoda nana,* the smallest, most apomorphic species of the family, is readily distinguished by its small size and head and terminalia characters, particularly the large epiproct and its basally broad sclerite. The form of the right tergal process and the development of the epiproct, with a tendency for a transverse membranous gap to intervene between these structures and the right hemitergite, constitute the first stage in evolution of the type of terminalia found in *Oligotoma, Oligembia,* and related genera.

Habitat.—Debris-covered galleries in crevices of stump bark in field at edge of virgin forest.

Acknowledgments

Fieldwork and laboratory studies were in part supported by grants from the National Science Foundation, John Simon Guggenheim Foundation, The Conservation Agency, and the National Geographic Society. The following individuals assisted in the field, or provided specimens for study: Dr. José Carvalho, Dr. St. von Kéler, Dyrce Lacombe, Clark E. Ross, and Dr. Evert I. Schlinger.

Literature Cited

Arnaud, P. H. 1963. *Perumyia embiaphaga,* a new genus and species of Neotropical Tachinidae (Diptera) parasitic on Embioptera. Am. Mus. Novit. 2143:1–8. 14 fig.

Cockerell, T. D. A. 1908. Descriptions of Tertiary Insects II. Am. J. Sci. (4)25:227–232.

Davis, C. 1939. Taxonomic notes on the order Embioptera. IV. The genus *Clothoda* Enderlein. Proc. Linn. Soc. N.S.W. 64:373–380. 25 fig.

———. 1940*a*. Taxonomic notes on the order Embioptera. XX. The distribution and comparative morphology of the order Embioptera. Proc. Linn. Soc. N.S.W. 65:533–542. 4 fig.

———. 1940*b*. Family classification of the order Embioptera. Ann. Entomol. Soc. Am. 33:677–682.

———. 1942. Report on a collection of Embioptera from Trinidad and Guiana. Proc. R. Soc. Lond. B. Biol. Sci. 11:111–119. 15 fig.

Denis, R. 1949. Ordre des Embioptères. Pp. 723–744 *in* Traité de Zoologie, Vol. 9, P. Grassé, ed. Masson et Cie, Paris. 14 fig.

Enderlein, G. 1909. Die Klassification der Embiidinen, nebst morphologischen und physiologischen Bemerkungen, besonders uber das Spinnen derselben. Zool. Anz. (Leipzig) 35:166–191. 3 fig.

———. 1912. Embiidinen. Coll. Zool. Selys-Longchamps. fasc. 3:1–121. 76 fig.

Friederichs, K. 1906. Zur Biologie der Embiiden. Mitt. Zool. Mus. Berl. 3:213–239. 19 fig.

Gerstaecker, A. 1888. Das Gemeinschaftsleben der Embiiden und Nahers zur Kenntnis der Arten. Mitt. naturw. Ver. Neuvorpom. und Rugen. 20:1–2.

Kaltenbach, A. 1968. Embiodea (Spinnfüsser). Pp. 1–29 *in* Handbuch der Zoologie IV. Band: Arthropoda—2. Hälfte: Insecta 2. Teil: Spezielles 8. 43 fig.

Kershaw, J. C. 1914. Development of an embiid. J. R. Microsc. Soc. 1914:24–27. Pl. 3, 4.

Kirkpatrick, T. W. 1957. Insect life in the tropics. Longmans, Green and Co. xiv + 311 pp., ill.

Krauss, H. A. 1899. Was ist *Condylopalama agilis* Sund.? Zool. Anz. (Leipzig) 22:147–148.

———. 1911. Monographie der Embien. Zoologica (Stuttg) 23:1–78. 7 fig., 5 pl.

Matsuda, R. 1960. Morphology of the pleurosternal region of the pterothorax in insects. Ann. Entomol. Soc. Am. 53:712–731. 38 fig.

Mc C. Callan, E. 1952. Embioptera of Trinidad with notes on their parasites. Trans. Ninth Int. Congr. Entomol. 1:483–489. 1 tab.

Melander, A. L. 1903. Notes on the structure and development of *Embia texana.* Biol. Bull. (Woods Hole) 4:99–118. 6 fig.

Navás, L. 1918. Embiópteros (Ins.) de la América Meridional. Broteria, Zool. ser. 16:85–110. 6 fig.

Ross, E. S. 1944. A revision of the Embioptera, or webspinners, of the New World. Proc. U.S. Nat. Mus. 94:401–504. 156 fig., 2 pl.

———. 1984. A synopsis of the Embiidina of the United States. Proc. Entomol. Soc. Wash. 86:82–93. 4 fig.

Saussure, H. de. 1896*a*. Two Embiidae from Trinidad. J. Trinidad Field Nat. Club. 2:292–294.

———. 1896*b*. Note sur la tribu des Embiens. Mitt. Schweiz. Entomol. Ges. 9:339–355. 1 pl.

Tillyard, F. 1937. Kansas Permian insects, pt. 18: The order Embiaria. Am. J. Sci. (5) 33:241–251. 3 fig.